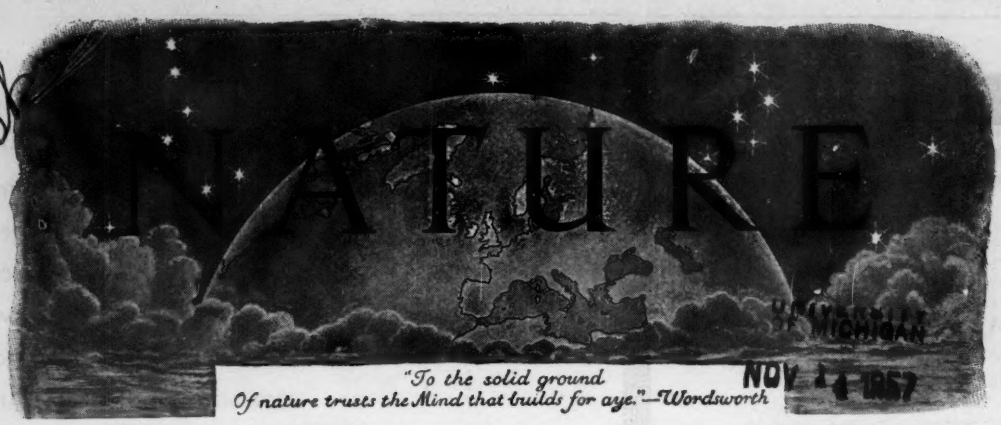

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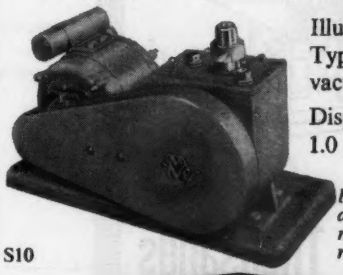

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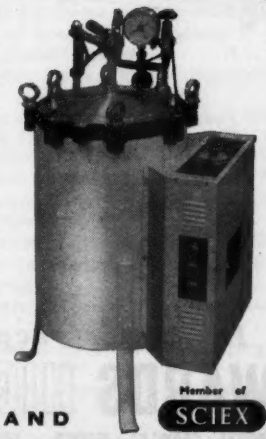

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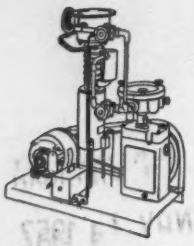

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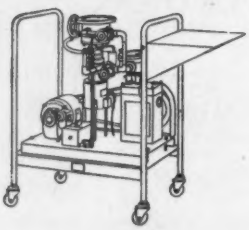

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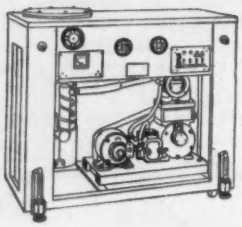

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AGENTS THROUGHOUT THE WORLD

NATURE

No. 4591 SATURDAY, OCTOBER 26, 1957 Vol. 180

CONTENTS

Page

Amenities, Rights of the Individual and the Needs of Development . . . 819

Crystallochemical Analysis. By Dr. F. C. Phillips . . . 821
Atomic Structures. By Dr. R. J. Eden . . . 822
Stereochemistry. By Dr. P. B. D. de la Mare . . . 822
Double Meanings. By Dr. A. D. Booth . . . 823
Solid Systems in Chemical Engineering. By Prof. J. M. Coulson . . . 823
Vector Analysis. By Dr. A. W. Gillies . . . 824
International Astronomy. By Prof. R. O. Redman, F.R.S. . . . 824

Cultivation of Embryonic Chick Bones on Chemically Defined Media. By Dr. J. D. Biggers, Dr. M. Webb, Dr. Raymond C. Parker and George M. Healy . . . 825
The Kiruna Geophysical Observatory, Sweden. By Dr. Bengt Hultqvist . . . 828
The Biology of Cancer . . . 830
Protein Structure and Biological Activity. By Dr. Kenneth Bailey, F.R.S. . . . 833

News and Views . . . 835

Soil Mechanics and Foundation Engineering. By D. J. Maclean . . . 839
Gas Chromatography. By Dr. C. S. G. Phillips . . . 840
Macromolecular Chemistry . . . 841
The Library Association . . . 843
Striving for Rigour in Greek Science . . . 843
Food Investigation, 1956. By Dr. P. L. Pellett . . . 844
The Mellon Institute . . . 845
The Forestry Commission . . . 846
'Angels' on Centimetric Radars caused by Birds. By W. G. Harper . . . 847
Moving Visual Images produced by Regular Stationary Patterns. By Dr. D. M. MacKay . . . 849
Protoplasts of *E. coli* as Sources and Acceptors of Deoxypentose Nucleic Acid: Rehabilitation of a Deficient Mutant. By Prof. Erwin Chargaff, Herbert M. Schulman and Dr. Herman S. Shapiro . . . 851

Letters to the Editors:

An Attempt to cross the Domestic Rabbit (*Oryctolagus cuniculus*) and Hare (*Lepus europaeus*).—Dr. C. E. Adams . . . 853

Absence of Wound Healing in Young Chick Embryos.—Prof. Paul Weiss and A. Gedeon Matoltsy . . . 854

Autoradiographic Detection of Sulphone in the Affected Tissues of Leprosy Patients.—R. K. Poddar and Dr. K. R. Chatterjee . . . 854

Effect of Hypoglycin *A* on the Alpha Cells of the Pancreas.—Dr. P. C. Feng . . . 855

Urinary Œstrogen Excretion by the Bull.—Weiert Velle . . . 856

Influence of Starvation and Glucose Load on the Activity of Liver Phosphorylase in Normal and Adrenalectomized Rats.—Dr. N. Schwartz Sørensen 857

Development of Chemical Thermoregulation in Piglets.—Dr. A. Holub, L. Forman and D. Jezková . . . 858

Glucuronic Acid Formation in Epiphyseal Cartilage Homogenate.—Alessandro A. Castellani, Benedetto de Bernard and Vittorio Zambotti . . . 859

Lipotropic Action of Ethyl Trichloracetate.—Dr. C. C. Kratzing and Dr. G. M. Windrum . . . 859

Chemical Nature of the Fluorescent Pigment produced in *Microsporum*-infected Hair.—Prof. Frederick T. Wolf . . . 860

Complexity of the Vanadium–Hydrogen Peroxide System.—Dr. G. Kakabadse and H. J. Wilson . . . 861

Frequency Drift of Short-Time Transients in Solar Radio Noise.—Öystein Elgaröy . . . 862

Strength of Highly Porous Brittle Materials.—K. Schiller . . . 862

A Protein Antigen associated with Smooth Colony Forms of some Species of *Pasteurella*.—Dr. M. J. Crumpton and Dr. D. A. L. Davies . . . 863

The Gum of *Fagara xanthoxyloides*.—Dr. F. G. Torto 864

Possible Occurrence of Strains in Species of Schistosomes.—B. Verdcourt . . . 865

Anatomy of *Polystoma integerrimum*.—Joan B. Williams 866

Potato Blight and Leaf-Roll Virus.—D. E. Richardson and D. A. Doling . . . 866

Growth and Properties of Bacterial Protoplasts.—M. H. Jeynes . . . 867

X-Ray Interferences of Barium Sulphate in Fungi and Algae.—Dr. D. R. Kreger . . . 867

The Treatment of the Mentally Ill.—Dr. Ronald McI. Johnson, M.P.; Editors . . . 868

Recent Scientific and Technical Books . . . Supp. vi

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AMENITIES, RIGHTS OF THE INDIVIDUAL AND THE NEEDS OF DEVELOPMENT

ON November 1, 1955, a Committee on Administrative Tribunals and Enquiries was appointed under the chairmanship of Sir Oliver Franks, "to consider and make recommendations on: (*a*) the constitution and working of tribunals other than the ordinary courts of law, constituted under any Act of Parliament by a Minister of the Crown or for the purposes of a Minister's functions; (*b*) the working of such administrative procedures as include the holding of an inquiry or hearing by or on behalf of a Minister on an appeal or as the result of objections or representations, and in particular the procedure for the compulsory purchase of land". Its inquiry thus involved the consideration of an important aspect of the relation between individual and authority, a relation which is not static, but requires adjustment from time to time if a reasonable balance is to be held between private right and public advantage, between efficiency of administration and fair play for the individual. Its bearing on efficient administration should of itself make the report of interest to the scientist as such; but its clear and trenchant exposition of what is involved and the principles which should determine both procedure and practice concerns him closely as a citizen. Nor need we look further than to the difficulties and opposition which have occurred in connexion with the Atomic Energy Authority's plans for nuclear power stations or its new research station at Winfrith Heath, or the many recent proposals to place such a station in the Snowdonia National Park and for an oil refinery at Milford Haven, in the Pembrokeshire National Park, to realize that procedure for the acquisition and use of land touches technical development and the utilization of the natural resources of Britain as well as the rights and needs of the individual citizen very closely indeed.

What the Franks Committee's report* has to say on the procedures by which the rights of individual citizens can be harmonized with wider public interest bears closely on this wider question of the reconciliation of the claims of varying public interests, of those of amenity, defence, water and power supply, forestry, agriculture, mineral resources and the like. The continued expansion of government activities and responsibilities, often enough as a result of technological development, has, in the past quarter of a century, since the Donoughmore Committee reported on Ministers' Powers in 1932, led to the establishment of many new tribunals and the extension of the activities of old ones, while far greater use is made of the powers to acquire land and control its use. Nor is any dissent likely from the conviction of the Franks Committee that tribunals as a system for adjudication have come to stay, and that the tendency for issues arising from legislative schemes to be referred to special tribunals is likely to grow rather than to diminish.

In such circumstances it is important, if not essential, that the issues should be clearly understood by the individual citizen. The Franks Committee points out that at the preliminary stage the most important requirement is that the citizen should be aware of and fully understand his right to apply to a tribunal. Later, it insists that fairness requires that those whose individual interests are likely to be affected adversely by the action proposed should know in good time before the inquiry the case which they will have to meet, and clearly this should apply equally to other public interests which may be affected. The Franks Committee was not satisfied that this requirement is always fully met, and it recommends various statutory changes in procedure in consequence. Likewise, it recommends that wherever possible some statement of the ministerial policy relevant to the particular case should also be available before the inquiry.

The recommendations that, unless the Minister has special reasons to the contrary, a public inquiry should be held in preference to a private hearing in connexion with the compulsory acquisition of land, development plans, planning appeals and clearance schemes, that the full text of an inspector's report should accompany the Minister's letter of decision and be available on request, and that the Minister's letter of decision should set out in full his findings and inferences of fact and the reasons for the decision, illustrate further the importance which the Committee attaches to this question of publicity. Lord Silkin does indeed dissent from the recommendation that reports of inspectors should be published, and the report itself sets forth some weighty arguments against publication, particularly in regard to the effect on frankness and on the relation between Ministers and their advisers. It is clearly a matter for judgment here as to which course is most in the public interest, but none the less the weight attached to publicity in general is not affected.

On that ground alone—all special considerations of scientific interest apart—it is important that the Franks report should be widely read and its statement and analysis of the issues clearly understood. As the committee points out at the outset, in Great Britain government rests fundamentally upon the consent of the governed, and the general acceptability of its adjudications is a vital element in sustaining that consent, as it is in securing that administration is efficient both in ensuring that the objectives of policy are securely attained without delay and in satisfying the general body of citizens that it is proceeding with reasonable regard to the balance between the public interest which it promotes and the private

* Report of the Committee on Administrative Tribunals and Enquiries. Pp. ii+115. (Cmnd. 218.) (London: H.M. Stationery Office, 1957.) 5*s*. net.

(or other public) interest which it disturbs. It could not be pretended that either requirement has been well served in the proposals for the new power stations at Trawsfynydd and Hunterston, for example.

The essential characteristics of these special procedures should be, the Committee suggests, openness, fairness and impartiality, though these characteristics need not necessarily be present in the same way and to the same extent at all stages: the Minister, for example, is committed to a policy which he is charged by Parliament to execute and, in this sense, he is not—and cannot be—impartial in his decision on an inquiry. The rule of law, however, stands for the view that decisions should be made by the application of known principles or laws, and in general such decisions will be predictable. On the other hand, a decision may have to be taken without principle and without any rules, and the Committee observes that methods of adjudication by tribunals are not in general the same as those of adjudication by Ministers; and where it is desirable to preserve flexibility of decision in the pursuance of public policy, a wise expediency is the proper basis of right adjudication and the decision must be left with a Minister. While, however, tribunals in their cheapness, accessibility, freedom from technicality, expedition and expert knowledge of their particular subject, possess advantages over the courts, the Franks Committee, as a matter of general principle, is firmly of the opinion that a decision should be entrusted to a court rather than to a tribunal in the absence of special considerations which make a tribunal more suitable, and no less firmly it insists that all decisions of tribunals shall be subject to review by the courts on points of law.

The Committee is satisfied that, in general, despite the haphazard way in which tribunals have developed, the method of decision by tribunals works reasonably well, and in considering what improvements and safeguards could be introduced into the present structure it remarks that openness appears to require publicity of proceedings and knowledge of the essential reasoning underlying the decisions; fairness to require the adoption of a clear procedure which enables parties to know their rights, to present their case fully, and to know the case which they have to meet; and impartiality to require the freedom of tribunals from the influence, real or apparent, of government departments concerned with the subject-matter of the decisions. In this last consideration we have to recognize the principle that neither individual nor department should be judge in his own cause, disregard of which has bedevilled questions of the use of land for almost two decades, and the Franks Committee itself, while satisfied that the requirement of fairness, to the importance of which much of the evidence submitted directed attention, was generally met, were not so satisfied that it held with some hearings before county agricultural executive committees. This appears to be due largely to the exercise by those committees of adjudicating functions in addition to their executive functions. This practice is regarded by the Franks Committee as wholly undesirable: while it exists, the parties cannot feel that their case will receive a fair hearing and be impartially decided. Furthermore, save in time of emergency or threat of emergency, it recommends that the Service departments should be required to adopt the same procedure for the acquisition of land as may be prescribed for other government departments, except where the appropriate Service Minister or his most senior official personally certifies dispensation on grounds of security in a particular instance.

As regards appeal to the courts, whatever procedure is devised—and it may well differ for different tribunals—it should be simple, cheap and expeditious. In the first instance, it should appropriately be to an appellate tribunal, followed, as already indicated, by an appeal to the courts on points of law. Nor is the Committee opposed to amalgamation of tribunals, though it rejects specific proposals made to them and recommends that whenever establishment of a new tribunal is proposed the possibility of vesting the jurisdiction in an existing tribunal should first be considered.

It is more critical of administrative procedures for the acquisition of land, and points out that these cannot be classified as purely administrative or purely judicial. The provision for a special procedure preliminary to the decision involves testing an issue often partly in public, and the final decision cannot be reached by the application of rules and must allow the exercise of a wide discretion in balancing public and private interest. Criticism of particular instances over the past decade and more has repeatedly turned on the failure or apparent failure to balance those interests and still more to balance rival public interests.

If the administrative view is dominant, the public inquiry cannot play its full part, and the rights and interests of individual citizens affected or other public interests may not be sufficiently protected, nor, save exceptionally, can Parliament provide such protection. The Franks Committee endorses the view that Parliament has neither the time nor the knowledge to supervise the Minister and to call him to account for his administrative decisions. On the other hand, the judicial view overlooks the fact that the Minister himself, who is responsible to Parliament for the ultimate decision, cannot conduct the inquiry in person.

In seeking a reasonable balance between the conflicting interests, which include, besides the responsibilities of Ministers and other administrative authorities and the rights and feelings of individual citizens affected, the public interest that Ministers and authorities should not be frustrated in executing their duties and that their decisions should be subject to effective checks or controls, the Franks Committee notes that dissatisfaction with procedures relating to land arises largely from the basis of compensation. Objections to compulsory purchase would be far fewer if compensation were always assessed at not less than

market values. This consideration lay outside the Committee's terms of reference, but it bears closely on the question of public confidence. It reiterates, in conclusion, that even if administrative procedures are changed and made as open as possible in the way suggested, public confidence will not be maintained, nor complete satisfaction given to those affected, if the basis of compensation is not regarded by them as reasonable.

There is a further important point. Wisely, the Committee emphasizes that no recommendation it can make will compensate for a wrong approach to administrative activity by the official concerned. It believes that there would be less public resentment against administrative action if all officials were trained in the principle that the individual has the right to enjoy his property without administrative interference unless that interference is unmistakably justified in the public interest. The attitude of an owner or occupier may well turn on whether he receives reasonable and courteous notice of a proposal to inspect the land.

The Franks report cannot be properly described as of scientific interest in the strict sense of the word. Nevertheless, it is of particular interest to the scientist both because its recommendations relate to the conditions which promote efficient administration and because so often the procedures described have been necessitated by technological development. The scientist, too, especially in view of his increasing responsibility for administration both in industry and in public affairs, might well pause to reflect on the principles so clearly enunciated in this fresh statement of the relations between individual rights and public interests, and how far those essential features of openness, fairness, impartiality—and courtesy—might not be applied in his own sphere of service and professional relations. With the growing complexity of administration and the multiplicity of technical issues in public life, it is increasingly essential that the channels of assent should be deeply dug.

CRYSTALLOCHEMICAL ANALYSIS

The Barker Index of Crystals

A Method for the Identification of Crystalline Substances. By Dr. M. W. Porter and R. C. Spiller. Vol. 2: Crystals of the Monoclinic System. Part 1: Introduction and Tables. Pp. v+383. Part 2: Crystal Descriptions—M.1 to M.1800. Pp. viii+760. Part 3: Crystal Descriptions—M.1801 to M.3572. Pp. viii+688. (Cambridge: W. Heffer and Sons, Ltd., 1956. Published for the Barker Index Committee.) £10 net the three parts.

CRYSTALLOCHEMICAL analysis aims at the identification of crystalline substances from measurements of their interfacial angles. The special advantages of this method lie in the ease and comparative speed with which even substances of highly complicated chemical composition can be identified by a procedure during which none of the material is consumed and also in the very small amount of material necessary.

In order that characteristic angles may be listed in numerical order, a standard setting and orientation must be selected for each substance. Apart from an early attempt by M. L. Frankenheim, systematization of data in this manner was first achieved by the work of E. S. Fedorov and his associates. His great work, "Das Krystallreich; Tabellen zur krystallochemischen Analyse", published in 1920, listed some 7,400 substances, of which 6,800 could be regarded as satisfactorily described. T. V. Barker, of Oxford, after spending a year under P. Groth at Munich, went on to work in Fedorov's laboratory and helped in the production of the "Tabellen". Extensive trials of the Fedorov method, however, ultimately convinced him that it was unlikely to acquire general acceptance as the basis for a practicable method of crystallochemical analysis. In his "Systematic Crystallography: an Essay on Crystal Description, Classification and Identification", published in 1930, he put forward a new scheme which was purely descriptive. Founding his choice of setting largely on the principle of simplest possible face-indices, by which a maximum of thirteen pairs of parallel faces may be given indices involving only the figures 0, 1 and $\bar{1}$, he abandoned the 'ideal', 'hypohexagonal', 'trigonaloid' and 'tetragonaloid' groups, set up by Fedorov partly on theoretical considerations, and used instead the orthodox crystal systems. Specimens of the kind of classification tables envisaged were given, but re-calculation of the data for about 8,000 non-cubic substances was a heavy task for an individual. Barker himself had only limited time available for scientific work after taking up an administrative post at Oxford, and he died in 1931. A number of crystallographers at Oxford, convinced that Barker's scheme was a great improvement on that of Fedorov and that it could be made the basis of a practicable crystallochemical index, arranged to press forward with the calculations and tabulation. The work was co-ordinated by a committee under the chairmanship of A. E. J. Vickers; valuable help was given by a group of Dutch crystallographers, working at the University of Groningen under P. Terpstra, and by individuals. Vol. 1, published in 1951, included the appropriate introductory matter and an index and descriptions of crystals of the tetragonal, hexagonal, trigonal and orthorhombic systems.

Vol. 2, now under review, brings the task measurably nearer completion. Concerned as it is with the monoclinic system, the 3,572 substances in this volume represent about one-half of the crystals to be described, and this proportion is reflected in the bulk of the three large parts into which the volume is divided. The arrangement follows closely that of Vol. 1. Part 1 begins with a 40-page introduction, by M. H. Hey, to the application of the Barker method to monoclinic crystals. Nineteen examples, worked through in some detail, are all organic substances chosen to illustrate various points of possible difficulty. The main classification angle used in the monoclinic system is *am*, between the faces (100) and (110), but a short auxiliary table lists also angles *ca*, between the faces (001) and (100), for a number of incompletely developed crystals. Other tables list the substances according to refractive indices (in order of β-index), densities and melting points (simple physical tests are often useful for confirmation of a crystallographic determination). There are also lists of English chemical and mineralogical

names and (an innovation since Vol. 1) of German names used by Groth in his "Chemische Krystallographie". A new feature also is a page of "Brief Directions" for the experienced crystallographer, a copy of which can be obtained for insertion in Vol. 1.

Parts 2 and 3 of Vol. 2 contain the 3,572 crystal descriptions. These parts, and the tabular matter of Part 1, have been reproduced from typescript by offset litho. As in Part 2 of Vol. 1, references are given under each substance to a standard chemical or mineralogical work as well as to Groth; some 125 substances not described by him are appended to Part 3. The descriptions include the matrix necessary to transform Groth's setting to the appropriate Barker setting, physical constants (including optical properties) and, where available, the spacings of the three strongest lines in powder photographs as given in the A.S.T.M. Index. During compilation it has been possible to correct a large number of errors, mainly in the calculations by original authors, which have been detected in Groth's descriptions. Quite aside from their use for purposes of identification, these two parts, together with Part 2 of Vol. 1, thus form a valuable compendium of up-to-date and accurate crystallographic information. Vol. 3 (dealing with crystals of the anorthic (triclinic) system) is in preparation. Its publication will complete an addition to crystallographic literature on which the committee and the editors are to be warmly congratulated.

F. C. Phillips

ATOMIC STRUCTURES

The Calculation of Atomic Structures

By Prof. Douglas R. Hartree. (Based on lectures given under the auspices of the William Pyle Philips Fund of Haverford College, 1955.) (Structure of Matter Series.) Pp. xiii+181. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1957.) 40*s*. net.

THIS book provides a simple account of methods used in calculations of atomic spectra. It has more the character of a guide to the subject rather than of an introduction, and is evidently intended for the specialist in a related field who becomes involved in atomic spectroscopy as an adjunct to his own work. It would also be of considerable value to the experimental spectroscopist who may be averse to advanced mathematics. The reader is assumed to have only an elementary knowledge of mathematics and quantum theory, although he must be reasonably familiar with descriptive or experimental atomic spectroscopy, and if he is to make full use of the book he must not have an aversion to tables of functions.

There are several drawbacks to this elementary approach which make the book less satisfactory as an introduction than as a guide to the subject. The principal one is that it has forced the author to describe mainly the methods which were used during the earlier development of calculations on atomic spectra, rather than the more powerful and elegant methods which were developed later but which involve more difficult mathematics; in particular, the work of Racah is mentioned only in a passing reference. Throughout, the author concentrates his attention on the methods of calculation rather than the general theory behind the methods; for the budding theoretical physicist this is very much putting the cart before the horse, but there is no doubt that Prof. Hartree's consideration will be appreciated by others less mathematically inclined.

The first chapter introduces Schrödinger's equation for an electron in a central field, discusses the separable wave function approximation for a many-electron system and outlines the idea of the self-consistent field which was introduced by the author in 1927 and which forms the basis of all methods of computing atomic spectra. The second and third chapters describe the variation method for obtaining the energy of a quantum system, illustrating it by an application to helium and then to a many-electron system. The variation method is related to the Fock equations and the Hartree equations, and it is shown how the use of determinantal wave functions reduces the problem to the calculation of certain types of integral.

Chapter 4 gives a brief description of the elements of numerical methods, quoting formulæ without proof but with readily accessible references. The application of these methods to the solution of the equations for the energy of an atom with a complete group of electrons is described in the next chapter, and in Chapter 6 this is extended to atoms with incomplete groups of electrons. Methods of interpolation which are of use in guessing trial wave functions are discussed in Chapter 7.

The remaining Chapters 8, 9 and 10 deal somewhat briefly with more advanced topics concerning the energy differences of different states of ionization (Chapter 8), the use of the Dirac equation for the electron (Chapter 9), and recent improvements on the self-consistent field method of approximation.

R. J. Eden

STEREOCHEMISTRY

Steric Effects in Organic Chemistry

Edited by Melvin S. Newman. Pp. vii+710. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1956.) 100*s*. net.

IN the early development of electronic theories of organic chemistry, much attention was focused on the influence of the polar effects of substituents on reactivity. To-day, now that this aspect of the subject has become extensively documented, increasingly more attention is being paid to stereochemical factors as they affect reaction-paths and mechanisms. Here must be considered not only bulk effects of substituents on the energy and entropy of activation, but also their effects in obstructing or enhancing the conjugative power of other substituents, the effects of varying the spatial relationships within the reacting molecule, and even the stereo-electronic considerations which determine whether bonds of particular types will be formed between pairs of atoms, and how strong these bonds will be.

Indeed, considering that organic reactivities are determined by the exact geometrical requirements and relationships of initial and transition states, a monograph on steric effects in organic chemistry has a very wide field to encompass. It is not surprising, therefore, that the work under review should be rather uneven in its coverage. In a number of chapters, equilibria and properties of ground-states of molecules are discussed; as in W. G. Dauben and K. S. Pitzer's account of conformational analysis; G. S. Hammond's discussion of equilibria between

acids and bases and in tautomeric systems; M. S. Newman's description of molecular complexes and molecular asymmetry; and L. L. Ingraham's account of steric effects on spectra and related properties. Other chapters deal more specifically with problems of relative reactivities. A particularly welcome and authoritative discussion of the calculation of the magnitude of steric effects is given by F. H. Westheimer. Substitution at a saturated carbon atom is described by E. L. Eliel; G. S. Hammond and M. F. Hawthorne discuss steric effects in aromatic substitution; and D. J. Cram gives accounts of intramolecular rearrangements and of olefin-forming elimination reactions. Cleavage of the carbon–carbon bond is described by H. H. Wasserman, and steric effects among the common organo-metallic compounds by G. F. Wright. M. S. Newman contributes a chapter on additions to unsaturated systems, and R. W. Taft discusses attempts to separate polar, steric and resonance effects on reactivity.

The contributors are all active in research, and have special interests in the fields which they cover. This adds to the interest and value of the work. Prof. Newman is to be congratulated and thanked for editing such an excellent volume. As a general criticism, it might be maintained that the American point of view is, in some chapters at least, promulgated with less than adequate judgment; but it is a book which will be of value to everyone interested in organic chemical reactivity. It is well indexed and well printed; its price will ensure that most chemists in Britain will consult it, when they need to, in their nearest library.

P. B. D. DE LA MARE

DOUBLE MEANINGS

Digital Calculating Machines and their Application to Scientific and Engineering Work

By G. A. Montgomerie. Pp. viii+262. (London and Glasgow: Blackie and Son, Ltd., 1956.) 30*s*. net.

The Management Approach to Electronic Digital Computers

By J. Sandford Smith. Pp. xi+227. (London: Macdonald and Evans, Ltd., 1957.) 35*s*.

NEITHER of these books achieves a very profound level of treatment of its respective subject, and they are, to a certain extent, complementary in their approach both as to the machines themselves and to the applications which are considered. G. A. Montgomerie's book is almost exclusively concerned with relatively simple devices of the desk-calculator variety, while that of J. Sandford Smith dismisses these useful tools in a few preliminary pages and then proceeds to a consideration of the newer electronic machines.

The prose style of both authors is good, but, whereas Sandford Smith nowhere descends to abstruse questions of notation and definition, Montgomerie attempts, in his introductory chapters, an obscure method of symbolizing digital operations which is likely to repel many readers.

A useful feature of both books is the attempt which is made to summarize the characteristics of available machines and to point out the way in which these may influence the prospective user in his choice, and although it may be argued that a short practical trial is worth any amount of verbal description, this is not always possible, especially with the large machines.

Montgomerie's book is divided into twelve chapters. The first is introductory, the next two deal with adding machines, and Chapters 4–7 are concerned with machines which can multiply and divide. Then follow a chapter on numerical analysis and two on punched card machines and special purpose machines respectively. The remaining Chapters (10–12) describe automatic digital calculators and programming. Major faults are the extremely superficial chapters on numerical analysis and on special purpose machines. In the former the Newton–Raphson method for evaluating square roots is illustrated by a ponderous numerical example, but the author does not seem to think it worthy of mention that the process is an error-squaring one. The title of the book indicates that scientific and engineering applications are covered; but their only real mention occurs in Chapter 9, where the highly atypical Beevers–McEwan Fourier synthesizer occupies most of the space.

Sandford Smith's book has seventeen chapters, two appendixes, a bibliography and a glossary. After two introductory chapters, Chapters 3–8 discuss the units of a computer, 9 and 10 programming and checking, 11–13 the approach of the business executive to the acquisition of a machine. Then follows a chapter describing the available British machines, and the book concludes with essays on the impact of automation on the auditor and the worker. The first appendix contains an extract from the amusing "Rambles through Binland" by Michaelson and the second an account of the clerical operations involved in such things as agriculture, mining and building. There is little to criticize in the book, which (unless it is merely in the mind of the reviewer) must surely be unique in presenting a mathematical diagram (p. 97) which contains a dubious joke.

Both books are well written and reasonably priced: though neither can be described as authoritative they will doubtless find a wide circle of readers.

A. D. BOOTH

SOLID SYSTEMS IN CHEMICAL ENGINEERING

Chemical Engineering Practice

Edited by Herbert W. Cremer and Trefor Davies. Vol. 3: Solid Systems. Pp. vi+534+xviii. (London: Butterworths Scientific Publications; New York: Academic Press, Inc., 1957.) 95*s*.

THE third volume in the series "Chemical Engineering Practice" is devoted to solid systems. The main subjects discussed in the first section are crushing, grinding and methods of analysing the size of solid particles. The second section covers screening, grading and classifying, in which are included flotation, sedimentation, coal-washing and air-flow selection. There are then two chapters on the mixing of solids, and on the storage and handling of solid material. The final section of this volume contains two chapters on gas cleaning with cyclones and electro-precipitation.

These are subjects in which, in general, the main designs of equipment have come from prolonged practical experience rather than from the logical application of physical concepts. While the modern

ideas of chemical engineering science are indicating some of the important fundamentals in these processes as, for example, in the mixing of solids and the settling of particles, it is not yet possible to make an entirely satisfactory design simply by using these physical concepts, and sound practical experience is essential in specifying equipment.

Dr. Heywood has given a short and clear account of the principles of crushing and size analysis, but the recent work of Bond and Rose might well have received greater emphasis. Messrs. Farrant and North have given a splendid account of crushing and grinding equipment, including practical data on the performance of machines.

All the chapters are written by men with wide experience of the industry, and they have given us valuable results arising from their work. Each chapter contains an account of the theoretical principles as at present understood, but the main emphasis is on the performance and use of existing equipment. Mr. Forbes Stewart has introduced two simple calculations on the design of sedimentation equipment and more illustrations of this kind would be welcome. Examples of methods used by practical men in design are always to be encouraged.

We are given results of the experience of those who have worked for many years in the various fields, and we must be indebted to them and to Mr. Cremer and Mr. Davies for providing this information. It is clear that in this area of chemical engineering there is a considerable amount of research and development to be done before the physical concepts are fully established and can be applied in a quantitative manner.

This book is well presented and will be welcomed by a large number of practising engineers.

J. M. Coulson

VECTOR ANALYSIS

Vector Analysis

By Prof. Louis Brand. Pp. xiv+282. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1957.) 48*s*. net.

In this book the subject is carried as far as is required by a course of first-degree level, the treatment being rather more elementary than in the author's "Vector and Tensor Analysis".

Starting with a vector as a directed line segment, the rules of vector algebra are developed in Chapter 1, including the various products and the use of reciprocal bases. The examples include vector proofs of geometrical theorems such as Desargues's theorem as well as the more usual applications to planes and straight lines.

After a short chapter on line vectors (that is, vectors localized in a line), and statics, we have three chapters in which variable vectors, differentiation and integration are developed. Chapter 3 on functions of one variable includes the curvature and torsion formulæ, velocities, accelerations and kinematics of a rigid body.

Chapter 4, differential invariants, includes a brief discussion of dyads and dyadics, and the divergence and rotation of a vector point function are obtained as the invariants of its gradient dyadic. This enables some results in this and the following chapter on integral theorems to be obtained more neatly. These two chapters cover the standard theorems in vector calculus of Gauss, Green and Stokes, with some discussion of solenoidal and irrotational vector fields. Formulæ are derived in general orthogonal co-ordinates, but the examples are limited to polar and cylindrical co-ordinates.

A rather elementary chapter on dynamics is then followed by one on fluid mechanics and one on electrodynamics in which the application of the theory is illustrated. The electrical theory is developed from Maxwell's equations, rationalized M.K.S. units being assumed. A short paragraph on units and dimensions is included, and an appendix lists the names and dimensions of the various units.

In the last chapter the reader is brought back to abstract theory with an introduction to vector spaces.

The book is well produced. The writing is clear and simple, and the theory is illustrated by many examples. In fact, it can be recommended without reservation.

A. W. Gillies

INTERNATIONAL ASTRONOMY

Transactions of the International Astronomical Union

Edited by P. Th. Oosterhoff. Vol. 9: Ninth General Assembly held at Dublin, 29 August to 5 September 1955. Pp. ix+802. (Cambridge: At the University Press, 1957.) 80*s*. net.

This volume is devoted for the most part to the proceedings of the meetings of the International Astronomical Union at Dublin in 1955. There are reports and discussions of some forty commissions and of about half that number of sub-commissions. A very wide range of work is covered and the reports themselves also vary a great deal, from brief summaries and recommendations to long critical surveys of recent research, complete with bibliographies. In addition there are accounts of four joint discussions, in each of which several commissions took part, dealing respectively with solar flares, photoelectric image tubes, fundamental stars (for positional measures), and turbulence in stellar atmospheres. The proceedings of three more elaborate symposia, on non-stable stars, radio astronomy, and a comparison of the large-scale structure of the galactic system with that of other stellar systems, are to be published separately. The first of these, in fact, has already appeared.

The International Astronomical Union is one of the oldest and most successful of the international unions. This is not to say, however, that its members are completely satisfied. Rather drastic steps are now being taken to change the commissions, some of which have in recent years become altogether too big and unwieldy, into much smaller and more compact groups. Further, the general growth in membership has led to some loss of the close personal contact and interchange of ideas which were such a happy feature of early meetings of the Astronomical Union and of the Solar Union before it. To meet this difficulty, quite small discussion meetings on special topics are now being organized outside the General Assembly, and these so far have proved very successful.

One part or another of these Transactions will be essential reading for every active astronomer, even if relatively few go through the whole volume. Any other scientist who wishes to get a fairly accurate idea of what modern astronomy is—neither old-fashioned routine on the observational side, nor irresponsible speculation on the theoretical—would do well to take a serious look at this book.

R. O. Redman

CULTIVATION OF EMBRYONIC CHICK BONES ON CHEMICALLY DEFINED MEDIA

By Dr. J. D. BIGGERS
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Dr. M. WEBB
Strangeways Research Laboratory, Cambridge
AND
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Connaught Medical Research Laboratories, University of Toronto

THE culture of organs is a specialized form of tissue culture. By suitable methods it is possible to maintain embryonic organs *in vitro* in a differentiated state under conditions that permit the study of their growth and metabolic activities. We have recently employed chemically defined media, which were originally devised for chick and mouse cells, for the cultivation of the cartilaginous femora and tibiæ of 6–7 day chick embryos, and our main findings are summarized here in order to illustrate the type of result that can be obtained with these media. Fuller descriptions of special aspects of this work will be published later. The further development of this field of investigation is important for the quantitative study of the relation of specific substances, for example, hormones, vitamins and amino-acids, and their metabolism to processes of growth and differentiation.

Although previous work on chemically defined media has been largely concerned with unorganized growth, a few papers have recorded the results of using such nutrients in organ culture. Spratt[1] utilized a medium based on White's formula[2] for cultivating early chick blastoderms. Et. Wolff and his colleagues[3] described the growth of embryonic chick tibiæ, gonads and syringes on a fairly simple mixture of amino-acids, vitamins and inorganic salts made up in agar. More recently, Trowell[4] has designed a slightly more complex medium for the culture of mammalian lymph nodes.

Three basic media have been used: 770, 858 and 929; these were prepared in the University of Toronto, Toronto, Canada, and sent by air to the Strangeways Research Laboratory, Cambridge, where many of the experiments were done. Some of the later experiments have been performed in the Department of Physiology, Royal Veterinary College, London.

Medium 770 is identical with medium 703 except for the addition of 0·1 per cent chondroitin sulphate[5]; medium 929 differs from medium 858 in that the concentration of all amino-acids is doubled[6].

The femora and tibiæ from 6½–7 day old chick embryos were used in this work. It must be emphasized at the outset that the embryonic bones are cartilaginous rudiments with only a slight degree of periosteal ossification as a collar around the diaphysis. The bones were cultured by the floating lens paper technique devised by Chen[7] for use with liquid media. In all but the isotope experiments the volume of medium in each culture vessel was 0·5 ml.; in some experiments, at the end of a culture period, the medium was recovered quantitatively for biochemical analysis. Three responses of the bones have been measured: length (from camera lucida drawings), wet weight and total nitrogen. These responses, however, have not been measured concurrently in all experiments.

The femur and tibia from one limb were usually kept together in the same culture vessel and thus constituted the experimental units that were allotted at random to the treatments in the different experiments. Three types of experimental design have been used: completely randomized, split-plot and the balanced incomplete block. In the first design, considerable reduction of experimental error was achieved by eliminating the effects of variations in the initial length of the bones by an analysis of covariance. The second and third designs were used specifically for exploiting the uniformity of paired bones from the same embryo. All experiments have been analysed by standard analysis of variance procedures[8] following transformation of the observations to the logarithmic scale.

Growth of the Bones

The bones were cultivated for twelve days in medium 929 containing glucose 2·25 mgm./ml., the medium being renewed every fourth day. After ten days *in vitro*, the average length of the femora increased by 110 per cent, and that of the tibiæ by 120 per cent, over their initial length. A subsequent factorial experiment[9] demonstrated that for a given level of glucose in the medium greater elongation is obtained when the medium is changed more frequently. The bones remained fairly normal in shape (Fig. 1), although this was not always so, since the ends of the rudiment sometimes became attached to the lens paper and therefore the bone was forced to bend when it elongated.

The same degree of elongation is observed over a four-day period of cultivation on both media 858 and 929, but is less in medium 770. Since several components were changed in the development of medium 858 from 703, it is not possible to attribute the greater response obtained with medium 858 to any particular constituent.

Histological examination of bones that have been cultivated for periods up to six days shows the normal structure, but in those grown for six days or more, degenerative changes are usually present, particularly in the diaphysis. The degeneration is slight at six days (Figs. 2, 3 and 4), but thereafter it becomes widespread. A collar of periosteal bone is present around the diaphysis. Until further work is done, however, it is not possible to state whether ossification

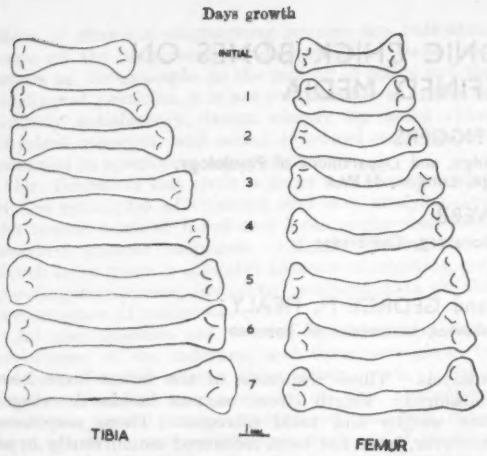

Fig. 1. Daily camera lucida drawings of an embryonic chick femur and tibia cultivated on medium 929 (glucose concentration 2·25 mgm./ml.). The medium was renewed on the fourth day

continues in bones cultivated on this medium. Other histochemical studies have shown that, after cultivation on the chemically defined medium, the matrix of the cartilage stains metachromatically with toluidine blue.

The rudiments differ in some respects from those kept for the same time on a natural medium containing serum, although they elongate to about the same extent on both nutrients. Very often the shafts of the bones grown on media 858 and 929 are flattened and slightly distorted, and the rudiments have a translucent appearance. Bones grown on media containing serum are more normal in shape, appear much denser and weigh significantly more than those grown on medium 929 ($0{\cdot}05 > P > 0{\cdot}01$).

Utilization of Amino-Acids from the Medium

A series of experiments have been made to investigate the disappearance of amino-acids from the medium during four days cultivation. The medium was quantitatively recovered and analysed for total amino-nitrogen by a ninhydrin method[10]. The ninhydrin colour given by the medium before use is due almost exclusively to amino-acids. Throughout the cultivation period, however, a quantity of ammonia may be formed, the presence of which would contribute to the intensity of the colour produced.

Table 1 shows the amino-nitrogen that is utilized during cultivation of the femur and tibia for one and four days on media 770 and 858. Although the extent of the interference due to production of ammonia is unknown in these experiments, the results clearly demonstrate that there is considerable loss of amino-nitrogen from the medium. The utilization of individual amino-acids from the medium can be conveniently followed by ion-exchange chromatography. Preliminary results, illustrating the application of the method of Moore and Stein[11] to the determination of the amino-acid metabolism of bone rudiments, have been described elsewhere[9]; this work has been considerably extended by Lawson and Lucy (unpublished observations).

Table 1. Amino-nitrogen (μgm.) utilized from 0·5 ml. Medium by a Femur and Tibia after 1 and 4 Days Cultivation (Means of 8 Observations)

Days cultivated	Medium 770	Medium 858
1	7·59	6·77
4	15·1	18·2

Incorporation of amino-acids into the protein of the explants has been shown by the uptake of radioactivity by the bone rudiments cultivated for 24 or 96 hours in medium 929 supplemented with glycine-$1^{14}C$ (0·04 mgm. = 1·32 μc./5 ml. medium). In these experiments the bones were extracted to remove lipids and nucleic acids, and the protein residues hydrolysed for 18 hr. with 6 *N* hydrochloric acid at 110° C. After removal of the hydrochloric acid *in vacuo*, the liberated amino-acids were separated by two-dimensional chromatography on paper[12]. Autoradiography of the chromatograms showed high activity in the glycine spot. Activity was also present to a lesser extent in serine, indicating some synthesis of this amino-acid from glycine. It is probable that, in addition to glycine, certain other amino-acids, for example, aspartic acid and glutamic acid, are utilized both directly through incorporation into protein and indirectly through the synthesis of other cell components.

In other experiments, in which bones of a similar size were used, it was found that during four days cultivation the combined total nitrogen of a femur and tibia increases by only 1·38 μgm. Thus, only a fraction of the amino-nitrogen that disappears from the medium reappears in the bones. The deamination of amino-acids by the bone rudiments has not been investigated in detail, although evidence from other

Fig. 2

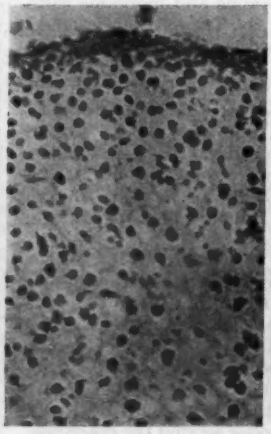

Fig. 3

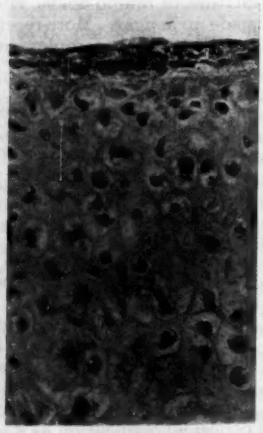

Fig. 4

Fig. 2. Seven-day old embryonic chick tibia after six days cultivation on medium 858. The medium was renewed on the third day (× 12). The structure of the bone appears normal with distinct epiphyseal cells and hypertrophic cells

Fig. 3. Part of the epiphysis of the specimen shown in Fig. 2, showing viable rounded cells (× 244)

Fig. 4. Part of the diaphysis of the specimen shown in Fig. 2, showing the periosteum and hypertrophic cells (× 244). The zone of ossification occurs between these two layers

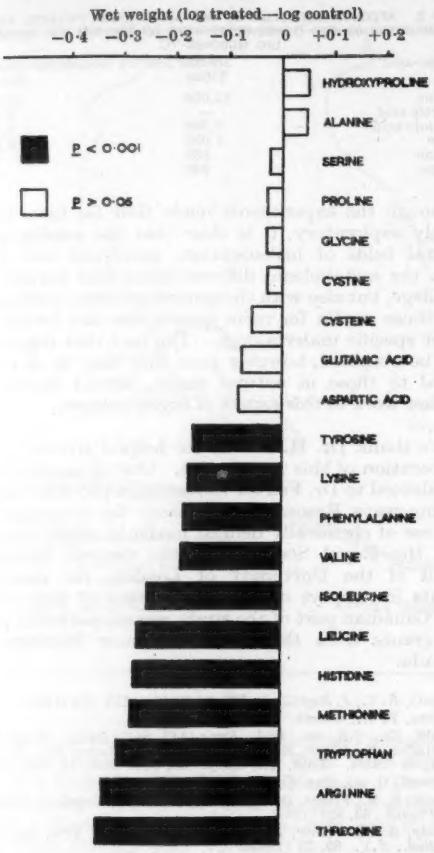

Fig. 5. Effect of individual amino-acid deficiencies on the wet weight of the bones after six days cultivation. The medium was renewed on the fourth day. Control medium: 858 (glucose concentration 2·25 mgm./ml.)

systems [in which both ammonia and total amino-acids have been determined suggests that deamination accounts for much of the decrease in amino-nitrogen[9]. In the bone cultures, pyruvic acid, α-keto*iso*valeric acid and α-keto*iso*caproic acid, the deamination products of alanine, valine and leucine, respectively, have been isolated from medium 929 after a four-day culture period.

'Essential' Amino-Acids

The results described in the previous section demonstrate that amino-acids are utilized from the medium during the incubation period. This raises the question of whether or not certain amino-acids are 'essential' for growth under the conditions of the present experiments. It was considered worth while, as an initial step, to perform *in vitro* experiments on the bone rudiments analogous to the classical deficiency experiments of Rose on the whole animal. It must be remembered, however, that recent nutritional studies on whole animals have demonstrated that the determination of these 'essential' requirements is a very complex process[13], because of the way in which the level of one component of the diet may determine the requirements for another. These, and several other related problems, have been discussed recently with reference to the design of chemically defined media by Biggers, Rinaldini and Webb[9].

Twenty media were prepared, each deficient in one amino-acid, and the response obtained with each of these media was compared with that on a control medium containing all the amino-acids. A double-strength stock medium (858) containing no amino-acids was prepared in Toronto. Just before use, this medium was diluted with the appropriate amino-acid solution. The amino-acids used were all of the L-form and had satisfied critical tolerance tests for purity.

The results obtained with the tibia are summarized in Fig. 5. The response has been estimated in terms of wet weight, a measure that has been found in other experiments to be highly correlated with total nitrogen. Since the work could only be done in several experiments, a control treatment was included in each, and the response expressed as $D = T - C$, where in a particular experiment T is the mean logarithm of the wet weight of bones subjected to a specific deficiency and C is the mean logarithm of the wet weight of the control bones. The effect of any one deficiency has been studied in two independent experiments of different design. Thus, two estimates of D were available, and these were found to be consistent with one another, within the limits of experimental error. The results shown in Fig. 5, therefore, are the weighted means (D_w) of these two estimates, the weight attached to each being the reciprocal of the corresponding variance[14].

If the amino-acid is 'non-essential', the value of D_w is expected to be zero. We may calculate the variance of D_w and use a t test to compare D_w with zero. If the probability of the test is less than 0·05, the amino-acid is said to be essential; otherwise it is non-essential.

Fig. 5 shows that nine of the amino-acids are non-essential under the conditions of the experiments, although glutamic acid and aspartic acid are on the border-line. The remaining eleven are all essential to a very high level of significance, and thus the amino-acids fall into two clearly defined groups.

Deficiencies of some amino-acids, for example, threonine, arginine (Fig. 6) and tryptophan, produce

Fig. 6. Living tibiæ after six days cultivation: (*a*) control medium; (*b*) an arginine-deficient medium. Both were from the same embryo and initially of approximately equal size. (× 15)

a great depression of growth. In these the deficiency appears very early and can be discerned within 48 hr. of setting up the cultures. The effects of other amino-acids are manifested more slowly; for example, lysine deficiency. Possibly this is due to the presence of stores of the amino-acid in the bone and a slow rate of utilization.

The amino-acid requirements of 7-day old embryonic chick tibiæ have also been studied by Kieny, Haffen and Wolff[15]. These workers have found that only certain amino-acids are required, but there is not full agreement with our results. Since the conditions of their experiments, both in regard to the nature of the medium and the culture technique employed, differ considerably from ours, it is not possible to explain these differences until more work has been carried out. The investigation of these discrepancies should provide valuable information on the function of amino-acids in the development of embryonic cartilage.

Synthesis of Amino-Acids from Glucose

The fact that the omission of certain amino-acids from the medium has no effect on the growth of the rudiment raises the question of the ability of the tissue to synthesize these compounds from other constituents of the medium.

Since a likely source of amino-acids is glucose, we have carried out experiments in which generally glucose labelled with carbon-14 was added to medium 858. After 24 hr. incubation on this supplemented medium, the bones were fractionated and the protein residue hydrolysed with hydrochloric acid. The amino-acids were separated by two-dimensional chromatography and the radioactive spots located by autoradiography. Areas of the paper bearing these active components were cut out and the individual amino-acids eluted with water. Samples of these eluates were assayed both for radioactivity and amino-acid content, and from these results the specific activities shown in Table 2 were obtained.

It can be seen that radioactivity is present in alanine, aspartic acid, glutamic acid, serine, glycine and proline, indicating that glucose can act as a source of all these 'non-essential' amino-acids.

Table 2. Specific Activities of the Amino-acids isolated from the Proteins of the Bones cultivated on Medium 858 containing Glucose-^{14}C

Amino-acid	Specific activity (counts/min./μmole)	
	Tibiæ	Femora
Alanine	12,000	13,500
Aspartic acid	—	8,900
Glutamic acid	7,700	6,800
Serine	1,930	2,300
Glycine	930	680
Proline	840	—

Conclusion

The results summarized in this paper demonstrate that growth processes can be studied in embryonic bones cultivated on chemically defined media. Although the experiments made thus far have been purely exploratory, it is clear that the results open several fields of investigation, concerned not only with the metabolism, differentiation and growth of cartilage, but also with the general problem of improving these media for more general use and for use in other specific undertakings. The fact that responses can be obtained, however poor they may be as compared to those in natural media, should encourage further work in this aspect of organ culture.

We thank Dr. H. B. Fell for helpful advice in the preparation of this manuscript. One of us (J. D. B.) is indebted to Dr. Fell for the facilities provided at the Strangeways Research Laboratory for investigating the use of chemically defined media in organ culture, and the Royal Society and the Central Research Fund of the University of London, for generous grants in support of the later phases of this work. The Canadian part of the study was supported in part by grants from the National Cancer Institute of Canada.

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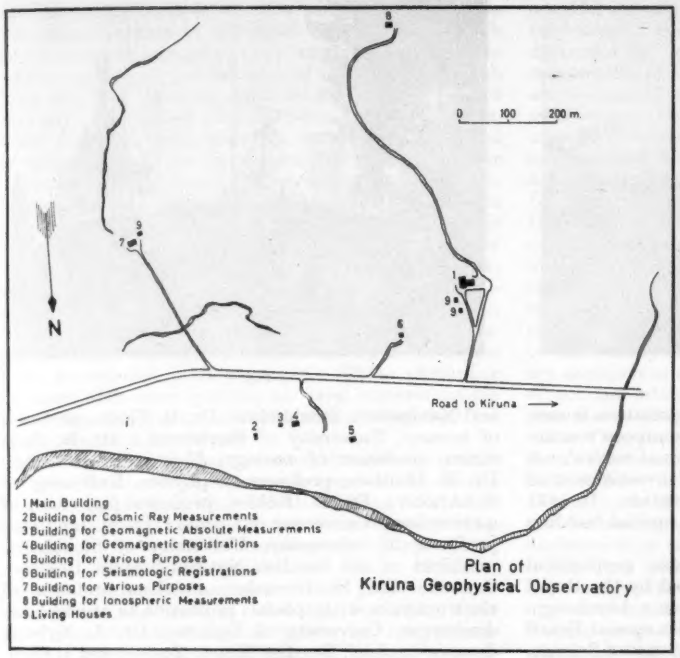
THE KIRUNA GEOPHYSICAL OBSERVATORY, SWEDEN

By Dr. BENGT HULTQVIST
Director

At a ceremony on July 2 marking the formal opening of the new Kiruna Geophysical Observatory in northern Sweden, the Royal Swedish Academy of Science accepted from the contractors the new central observatory building and the ionospheric laboratory. Representing a decade of planning and work, this fine new facility in northern Sweden will enable geophysicists interested in arctic phenomena to carry on research under the most favourable conditions.

The dedication ceremonies were attended by more than a hundred guests, including the Governor of Norrbottens län and Mrs. M. Näslund; State Secretary Dr. Ragnar Edenman, representative of the Swedish Government; Prof. Bertil Lindblad, vice-president of the Royal Swedish Academy of Science; Dr. Hugo Larsson, director of the National Defence Research Group in Sweden; Mr. H. Nyström, head of the Kiruna City Council and State representative; various members of the Board which had


0 100 200 m.
N
Road to Kiruna
1 Main Building
2 Building for Cosmic Ray Measurements
3 Building for Geomagnetic Absolute Measurements
4 Building for Geomagnetic Registrations
5 Building for Various Purposes
6 Building for Seismologic Registrations
7 Building for Various Purposes
8 Building for Ionospheric Measurements
9 Living Houses

Plan of
Kiruna Geophysical Observatory

Fig. 1

been set up to deal with the funding and planning of the new Observatory, including Prof. Rolf Sievert, Dr. Nils Ambolt and Prof. Harald Norinder; Dr. L. V. Berkner and Dr. J. W. Joyce from the United States; Prof. J. Keränen and Prof. H. Franssila from Finland and Prof. Harang from Norway.

The Observatory consists of a main building and a series of smaller buildings for housing various types of instruments (see plan, Fig. 1, and Figs. 2–4). It occupies an area of 22·2 sq. km., which provides amply for future expansion, including the establishment of auxiliary observing sites where measurements over base lines of several kilometres are desirable. The geographical location is particularly significant with respect to the Geophysical Institute in Fairbanks, Alaska, because the two observatories are approximately 180° apart in longitude. This circumstance will make it possible for the two laboratories to undertake certain important types of transpolar research projects on a co-operative basis. Co-ordinates of the new Kiruna Geophysical Observatory are as follows: geographic co-ordinates, lat. 67·8° N., long. 20·4° E.; geomagnetic co-ordinates, lat. 65·3° N., long. 115·5° E. Corresponding co-ordinates for the Geophysical Institute at Fairbanks, Alaska, are: geographic, lat. 64·9° N., long. 147·8° W.; geomagnetic, lat. 64·5° N., long. 255·4° E.

The main building contains a series of laboratories, dark-rooms, administrative offices, combination library and seminar room, dining-room and lounge facilities, living quarters for investigators, a well-equipped mechanical workshop, and other features. One large laboratory room can be subdivided into three small rooms if necessary, each suitable for one or possibly two workers. A second laboratory provides facilities for several people, and five smaller rooms are equipped to accommodate one or possibly two people. General laboratory services are available in each of the rooms and special features have been added to certain of these.

On the upper floor of the main building is a heated glassed-in laboratory. Above this is an open deck on which can be mounted equipment requiring all-round seeing conditions. The mounting facilities are provided with supports that go down to foundations and are independent of the structure of the building itself.

The main building includes living quarters for the director and for a general caretaker and six individual sleeping rooms for visiting investigators. Two small cottages, at present under construction, will provide living space for permanent staff members.

A grant from the U.S. National Science Foundation has made it possible to equip the Observatory with good basic instrumentation.

Both normal and quick-run geomagnetic records of X, Y and Z have been taken regularly for several years. The aurora is studied with a Stoffregen all-sky camera. A panoramic ionosonde was set up in a

Fig. 2

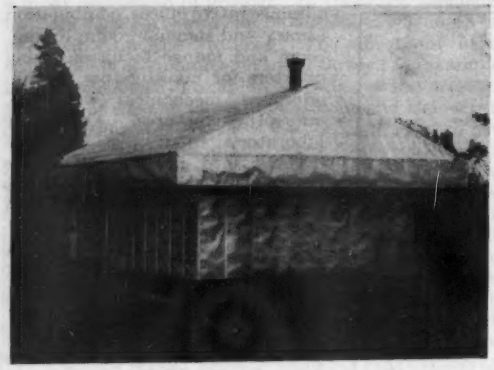


Fig. 3

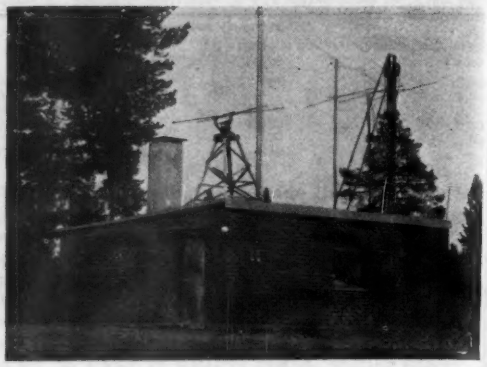


Fig. 4

provisory building in 1948. Two registration houses are now accommodating two special-purpose cosmic-ray telescopes besides two 'international cubics'. A widely separated set of counters for investigation of extensive air showers is under construction. In 1951 four seismographs were installed in a special building at the Observatory.

The establishment of a first-class geophysical observatory near Kiruna was proposed by the Royal Swedish Academy of Science more than a decade ago. Its planning has been in the hands of a special Board appointed by the Royal Swedish Academy of Science. The members of this Board are: Senator Dr. R. Sandler (chairman); Dr. R. Sievert (vice-chairman), professor of radiophysics, Royal Caroline Medical-surgical Institute, Stockholm; Dr. H. Alfvén, professor of electronics, Royal Technical University of Stockholm; Dr. N. Ambolt, director of the Section of Terrestrial Magnetism, Royal Board of Shipping and Navigation, Stockholm; Dr. R. Florin, professor of botany, University of Stockholm; Dr. B. Hanström, professor of zoology, University of Lund; Dr. E. Hulthén, professor of physics, University of Stockholm; Dr. H. Köhler, professor (emeritus) of meteorology, University of Upsala; Dr. B. Lindblad, professor of astronomy, University of Stockholm, president of the Swedish Natural Science Research Council; Dr. H. Norinder, emeritus professor of electrophysics with special application to atmospheric discharges, University of Upsala; Dr. A. Nyberg, director-in-chief, Swedish Meteorological and Hydrological Institute, Stockholm.

We welcome suitable research proposals, particularly where appropriate financial support can also be provided. All proposals by those interested for co-operative activities should be addressed to the Director, Kiruna Geophysical Observatory, Kiruna, Sweden.

THE BIOLOGY OF CANCER

THERE has been an increasing awareness in recent years among those engaged in research of a need for a more fundamental biological approach to the problem of cancer. The general study of viruses was, at one time, looked upon as a pathological problem; but it is now recognized as of importance both in its general biological aspects and in the elucidation of the microstructure of cellular systems. It was therefore refreshing to find this view reflected in a whole-day discussion on "Biological Aspects of Cancer" held by Section D (Zoology) of the British Association in Dublin on September 6. Prof. Rogers Brambell, the chairman for the morning session, regretted the tendency to separate the study of cancer from the general framework of zoology, and emphasized the close relationship between protein synthesis and pathological changes within the cell. Prof. A. Haddow (Chester Beatty Research Institute), who opened the discussion, stressed the fundamental similarity between embryonic and cancer cells, and the need for more information concerning the development of specific enzymes during embryonic development and differentiation.

It was unfortunate that Dr. Julian Huxley was prevented by illness from reading his paper. In some excellent recent reviews, he has stressed the importance of considering the zoological aspects of the problem. He looks upon tumours as constituting a separate major phylum of obligatory parasites, originating and usually perishing with the host, with a way of life most fruitfully considered in the general biological concepts of adaptation, evolution, population dynamics and the like.

Here it will be convenient to consider three aspects of the problem discussed at the meeting, namely, growth mechanisms and their regulation, population dynamics of tumours and the nature of the intracellular transformation giving rise to the manifold properties of cancer cells.

The nature of the environmental controls, by which a healthy organism prevails upon its many cells to adopt and maintain a sociable way of life and which the cancer cells have to overcome, was tackled by several speakers. A knowledge of how these controls are effected remains a major problem of current biology, but there is little doubt that chemical substances, humoral factors, pass from organ to organ influencing both the function and size of the organs. Prof. E. S. Horning (Chester Beatty Research Institute) described the two types of cancer which arise

spontaneously in both animals and man. One type comprises a group of malignant tumours the growth of which can be controlled temporarily by an alteration of the hormonal environment of the body in which they develop. Cancers which respond to this kind of therapy are called hormone-dependent tumours. They are often, but not always, caused by a hormonal imbalance, and are dependent upon a particular hormone or combination of hormones for their sustained growth. Many of these tumours in both animals and man regress once the hormonal stimulus is withdrawn. Prof. Horning went on to describe tumours in the hamster induced by prolonged treatment with the synthetic female sex hormone stilbœstrol. These are an interesting example of a hormone-dependent lesion as they grow, when transplanted under the skin of hamsters, only if they have been pre-treated with œstrogen. These particular tumours have been growing as serial transplants for more than four years, and still remain dependent for their growth on hormones.

An example was also given of the induction of a prostate hormone-dependent tumour in the mouse without employing the direct intervention of a hormonal agent. This prostatic cancer was produced by treatment with one of the carcinogenic hydrocarbons, namely, 20-methylcholanthrene. Many of these primary prostatic tumours were glandular cell carcinomas, and were found to be dependent upon androgens for their maintenance as transplants. During serial transplantations, all these tumours eventually underwent squamous differentiation, and they then became independent of the male sex hormone for their sustained growth as grafts. The dividing line between the hormone-dependent tumours and those which are completely autonomous is not completely rigid. A certain number of dependent tumours, like the mouse prostate carcinoma, transform into autonomous variants, indicating some progressive type of cellular transformation.

In addition to cellular proliferation, tumours may be characterized by their degree of de-differentiation. Differentiation is the process whereby the potentialities of the cells become restricted from the totipotential state of the fertilized egg to the decreased potential state of a muscle cell, red blood cell or cornified cell. Dr. A. Glücksmann (Strangeways Research Laboratory, Cambridge) pointed out that in normal growths, as in epithelium, there is a balance between rate of growth and rate of differentiation. In the development of cancers, this balance may be altered in rate, quality, uniformity of progress and in the type of differentiation impaired. Such changes can arise independently of each other. As in the case of proliferation of cells, changes in differentiation can be brought about by extrinsic environmental conditions, such as hormonal factors operating on the normal or slightly impaired potentialities of the cancer cell.

Another type of change in the cell itself is an alteration of its surface properties. Evidence is accumulating that cell movement, for example, and possibly cell division, are influenced by contact with other cells. Dr. Abercrombie discussed the mechanism of cell movement, which is a property, like that of division, latent in most cells, but which becomes manifest again only when the environmental conditions alter, as in wounds or when cells are transferred to a culture medium *in vitro*. This work has been considerably assisted by the technique of interference-microscope cinematography, which reveals the dynamics of cell movements very clearly. The movements of fibroblasts and perhaps of other cells are associated with peripheral undulations of the cell membrane. When this undulating surface touches another fibroblast, the activity ceases at the point of contact and an adhesion may be formed. These adhesions occur in the phenomenon of inhibition by contact described by Abercrombie and Heaysman. If the cell is in contact with a sufficient number of surfaces its entire membrane becomes quiescent and movement ceases, as is the case in an established tissue. The discovery that cancer cells are not subject to contact inhibition may be of far-reaching importance. In mixed cultures cancer cells may be seen to move freely over the surfaces of normal cells, which are themselves held motionless, owing to the effects of contact inhibition. It would seem that we have here one of the secrets of the 'success' of the cancer cell. That contact inhibition is a potent factor in tissue construction would seem obvious; in gaining independence from its operation the cancer cell has clearly made the important step towards autonomy and its ability to invade normal tissues can also be understood on this basis.

The films indicate that sarcoma cells in culture do not form permanent adhesions between their undulating membranes. This suggests an alteration in the surface properties of cancer cells, a point of view which has long been held by Coman, who has demonstrated by direct manipulation that cancer cells are less sticky than normal cells. Cancer cells have also recently been found by Ambrose and his co-workers to carry a higher negative electrical charge than homologous normal cells. Clearly these properties are linked, but until more is known of what happens when one cell touches another and what makes some cells stick together and others not, the relationship between cell adhesion, contact inhibition and tissue construction can only be guessed.

The fine details of the structure of the cell membrane and of the contacts themselves are now within the province of the electron microscopist. Owing to the recent technical advances allowing the cutting of sections thin enough for electron microscopy, there has been a rapid growth in our knowledge of the fine structure of cells. Dr. E. H. Mercer (Chester Beatty Research Institute) described how these techniques are being adapted to the problem of cell contact and cell adhesion. By the choice of certain simple cell systems, such as the mammalian epidermis and a species of social amœba, in which the cells progress from a relatively free-living condition to form well-differentiated structures, the behaviour of the cell membranes can be followed. The external membrane of the amœbæ at high resolution is resolved into a lamellar structure about 60 A. thick, consisting of two dense surfaces enclosing a less dense layer. In some instances, the membranes of other cells can also be resolved in this way. The structure may correspond to the model of two protein layers spread over a lipoid-like layer proposed by Danielli. When two cells meet, the plasma membranes flatten out, implying that the cells 'wet' each other, but the dense layers of the membranes never actually meet. They remain separated by a thin layer of less-dense material, 150–200 A. thick. This suggests the presence of some extracellular cementing substance outside the plasma membrane.

Such a material should obviously play a key part in tissue formation and maintenance and will affect many of the surface properties of cells. The possibility of a loss in quantity or perhaps quality of this cement is suggested by electron micrographs of anaplastic tumours the membranes of which show poor attachment. In more differentiated tumours, however, the morphology of the contacts still appears normal.

The nature of the cell surface was further discussed by Dr. R. J. Goldacre and Drs. G. C. and D. M. Easty. Dr. Goldacre (Chester Beatty Research Institute) pointed out that many of the fundamental aspects of cell physiology can be studied with any type of living cell. The large *Amœba proteus* is a convenient test organism in which cellular changes can be seen much more easily by eye than in the smaller tissue cells. Certain carcinogens such as nitrogen mustards and diepoxides can be seen to have a direct tanning effect on the membrane, preventing the animal from retracting its pseudopods. He showed a film which indicated that at least a part of protein synthesis takes place at the cell membrane. Since there is considerable experimental evidence that the cell membrane is altered in cancer cells, this could account for an altered type of protein synthesis. Another possibility is that membranes are concerned in the transfer of information from one cell to another, and that this transfer could be impaired were the membranes modified.

Dr. and Mrs. G. C. Easty (Chester Beatty Research Institute) were concerned to show, by means of specific surface antisera, that the surfaces of the cells of different organs were different antigenically and that, in a particular transplanted tumour they examined, the tumour cells differed from normal cells. An antiserum to a cell can produce three effects: precipitation of cells, aggregation and a change in permeability of the membrane. This last effect can be particularly well seen in the interference microscope because it is associated with a sudden passage of cytoplasmic protein from the cell, which can be observed as a dramatic change of colour in the interference image. An antiserum against ascites cells contains antibodies against a variety of cells, but is purified by adsorbing against normal cells and can be obtained with an increased degree of specificity against the cancer cells. Films show that this antiserum reacts specifically with the membrane of cancer cells in the presence of other normal cells. This result raises the possibility of a tumour-specific antiserum in therapeutics, but requires further investigation using primary tumours. Dr. Easty also showed that in some tumours the antiserum reacts on some cells without affecting others, indicating the presence of a heterogeneous population.

In general biological terms we may now ask ourselves what is the origin of the new species of cells? Probably the new cells are mutants less under the control of those environmental factors which are able to repress the spontaneous tendency of the unmutated stock to divide. Mutants, capable of complete autonomy, probably do not arise in a single step. The initial variants may be supposed to have a slightly enhanced autonomy, but can probably only increase in a localized host environment where the normal powers of control are impaired by the action of some promoting condition. In such conditions, natural selection operating on a mixed population of altered cells may be relied upon to select a strain of increasing autonomy. Prof. P. C. Koller (Chester Beatty Research Institute) showed a selection of cell smears illustrating chromosomal variations. These provide visual proof of the fact of chromosomal change in cancer cells and also of the existence of numerous chromosomal variants in the cell population, implying the presence of mutant forms. This can clearly be seen in the diversity of chromosome number. These changes are brought about largely by abnormal mitosis, such as lack of synchronization of nuclear and cytoplasmic division. Multiple spindles, operating on a mass of chromosomes, and the occurrence of anaphase bridges also lead to variations in the nuclear size of daughter cells. Cellular polymorphism provides a basis for the operation of selection as the tumour develops, invades and occupies new situations. This may be shown by changes in the number of chromosomes between the primary and secondary tumours. Certain cell variants may also be favoured during therapeutic treatment when the cells are subject to radiation or chemotherapeutic agents. Prof. G. Klein of Sweden has also studied this problem using transplantation techniques, and has produced a number of strains from a single tumour which show differences in degrees of invasiveness and other biological behaviour.

The origin of the new types of cell, in chemical carcinogenesis, was discussed by Prof. Haddow. He pointed out that chemical carcinogenesis provides a direct experimental approach to this problem. Since the discovery of the carcinogenic hydrocarbons a number of comparatively simple chemical substances have been discovered which can induce cancer, for example, the nitrogen mustards, epoxides, and ethyleneimines. Their possible reactions with biological material are limited; the nitrogen mustards, for example, operate by alkylation. Those which are of a bifunctional nature are far more active biologically than monofunctional compounds. Another advantage of these compounds, from the point of view of experimental observation, is that they have a rapid effect upon the cell. A number of direct cytological changes are produced by these agents: fragmentation of chromosomes, anaphase bridges, interference with chromosome duplication, and formation of micronuclei. Such effects are also produced by radiation, and the substances are therefore called radiomimetic agents. The direct effect of these agents upon nucleic acid *in vitro* is known, and it appears distinctly possible that their biological reaction is with this component of the cell. They are found to have a marked mutagenic action in *Drosophila*. Although some alteration in the genetic constitution of the cell may be involved in the malignant change, control of growth in terms of cellular dynamics probably depends upon enzyme systems. Xanthopterin, for example, will produce a wave of mitosis in kidney tubules. Xanthine oxidase appears to be the enzyme which controls the level of xanthopterin in normal tissues, and there is some evidence that its concentration is reduced in some tumours.

There were some rather obvious omissions from the programme in Dublin. Little was said about the virus theory of cancer, although a number of mammalian tumours have recently been shown to be of viral origin. Nor was the immunological response of the host to a growing tumour examined. But it was obviously impossible to cover all these aspects in a single day.

PROTEIN STRUCTURE AND BIOLOGICAL ACTIVITY

PARIS SYMPOSIUM

IN 1951, a Commission on Proteins was created within the Section on Biological Chemistry of the International Union of Pure and Applied Chemistry. Its aim was to consider the possible need for, and provision of, a few standard proteins, rigorously tested by both chemical and physical methods, and available internationally to anyone who might wish to check his own methods against a standard. The first protein to be distributed in this way was a large batch of crystalline beef insulin*, prepared in Great Britain by the British Insulin Manufacturers.

The description 'standard' is used advisedly, for one is hesitant to apply any longer within the field of protein chemistry a term with the finality of 'homogeneous'. In recent years, the most respectable proteins have been resolved by several kinds of simple and sensitive techniques into two or more components, each perhaps with the same biological activity, but differing slightly in some chemical or physical feature. In some cases, it is not known how such 'microheterogeneity' arises; but just as Kossel in 1901 squarely faced the great diversity and complexity of proteins as a class—attributes which had taken fifty years to establish—so now the biochemist must anticipate the diversities which may arise in any one protein, either genetically as a mutation, as the result of species differences, as slight modifications in the course of preparation, or perhaps, as Pauling suggested, as an occasional mistake in the biosynthetic mechanism.

The Commission decided at its meeting in Zurich in 1955 that a symposium on protein structure and its relation to biological activity would greatly assist the Commission in evaluating the relevance of its earlier objectives. The executive committee of the International Union of Pure and Applied Chemistry, through Dr. Murray Luck, gave generous financial help, which enabled the organizers, Dr. Stanford Moore (United States), Prof. A. Neuberger (Great Britain) and Prof. J. Roche (France), to invite some twenty distinguished speakers and as many others to a symposium held in Paris during July 25–29, following the nineteenth Conference of the International Union of Pure and Applied Chemistry itself. Both papers and discussions will eventually appear as a monograph†, and the present account (prepared in the main without reference to manuscripts) cannot possibly do justice to the uniformly high standard of the communications, reflected by the enthusiasm of the audience in the congenial atmosphere of the Collège de France.

Following the usage of Linderstrøm-Lang, it is convenient to consider the structural concepts of proteins in terms of the primary structure (amino-acid sequence), secondary structure (*intra*-molecular configuration of the polypeptide backbone —CH.CO.NH—) and the tertiary structure (*inter*-molecular bonding and topography of the side-chains). Although our knowledge of secondary and tertiary structure is only fragmentary, it became evident during the meeting that a bold and imaginative approach by several workers had yielded fascinating results. It was also quite evident that the revolutionary progress in defining primary structure arises first from the application of many kinds of chromatographic techniques, and second from the introduction and expansion of end-group methods. It is not yet possible to assess in any historical sense the debt we thus owe to the pioneers in these fields, Martin and Synge on one hand, and Sanger on the other.

Primary structure. The complete elucidation of the amino-acid sequence in insulin has led to more ambitious attempts to determine that of much longer chains. Through the work of S. Moore and W. H. Stein, and of C. B. Anfinsen and their co-workers, one may anticipate very soon the complete sequence in ribonuclease, a chain of 124 residues, in which the positions of the intrachain disulphide bridges have already been allocated. Steady progress was also reported by Cl. Fromageot and his colleagues in the case of hen lysozyme (128 residues), a difficult protein by virtue of its high content of tryptophan. The structure of pig and ox adrenocorticotropic hormone, described by C. H. Li (39 residues), has a fascinating interest in view of the occurrence of amino-acid sequences common also to the α- and β-melanophore-stimulating hormones, the structures of which have been determined by C. H. Li and by J. I. Harris and their collaborators. Features which augment one type of biological activity at the expense of another are already apparent. The free amino-group in the terminal serine of corticotropin, which is correspondingly substituted by an unknown group in α-melanophore-stimulating hormone and by an additional peptide sequence in β-melanophore-stimulating hormone, appears to be necessary for its activity; if obliterated by oxidation, its corticotrophic activity is lost, although the slight melanophore-stimulating hormone activity persists.

In spite of the extension of sequence studies to these and other proteins and peptides, it is worth noting that the insulins are still the only proteins containing more than *one* polypeptide chain the complete structure of which is fully known.

Secondary and tertiary structure. The classical denaturing agents such as heat, acid, alkali and urea may induce reversible or irreversible changes of configuration which can now be followed by a variety of methods. K. Linderstrøm-Lang described the use of deuterium to study the exchangeability of the imide hydrogen atoms of the polypeptide backbone, and discussed the results obtained with poly-DL-alanine which is known to exist in the α-helical form of Pauling and Corey. The rate of exchange as a function of hydrogen-ion and hydroxyl concentrations has suggested that H-bonds can be broken singly only at the ends of the helix, whereas in other positions at least three must dissociate simultaneously. In both insulin and ribonuclease, the observations suggest that exchangeability is greatly restricted in

* *Nature*, **179**, 567 (1957).

† To be published by Methuen and Co. (Great Britain) and by John Wiley and Sons (U.S.A.).

some parts of the molecule, but is instantaneous in presence of denaturing agents, or after opening out the molecule by oxidation of the restraining intra- and inter-molecular disulphide bridges.

Changes in optical rotation, shifts in ultra-violet absorption, dilatometry and measurement of intrinsic viscosity may also reflect the extent of configurational change, and even where this is considerable, as in ribonuclease, biological activity can be retained. Indeed, the examples of this kind of phenomenon are now quite large, and have led two participants at the conference, Emil Smith and C. B. Anfinsen, to inquire how much of the protein molecule is simply 'junk'. Even covalent linkages may be extensively split as in the case of papain, discussed by Smith, where 50 out of 180 residues can be broken off by aminopeptidase without any loss in activity against five different substrates. B. G. Malmström's enolase —an enzyme occurring in several electrophoretically distinct forms—is also unaffected after the action of carboxypeptidase or of aminopeptidase, the latter splitting some eighty amino-acids from a particle of molecular weight 68,000. It is not very difficult in reality to envisage that an active centre can survive such changes, although we know too little about tertiary structure to predict whether it will or will not. Conversely, some slight change occurring near or within the active centre may abolish activity completely. In papain, only one —SH group out of six is chemically reactive, and this, if substituted, destroys activity. In ribonuclease, a covalent split four amino-acids from the C-terminal end inactivates, as does any modification of tertiary structure which results in the liberation of H-bonded phenolic groups.

The 'junk' hypothesis, while no doubt valid with respect to some kinds of biological activity, need have no general validity. Antibody formation, for example, is evoked by more than one configurational site of the antigen molecule. R. R. Porter described the isolation of a homogeneous fragment from an enzyme digest of serum albumin, less than one-fifth the size of the native protein. This, when studied immunologically, contains some of the sites involved in the binding of antibody (serum albumin itself being used as antigen), but others have been shed, and the behaviour of the fragment is still dependent upon the intactness of its tertiary structure. J. Reynaud has likewise shown that trypsin-digested tetanus toxin contains at least four products antigenically distinguishable in their combination with antibody.

In the broadest sense, the factors affecting the stability of a protein cannot readily be generalized. C. Tanford pointed out that effects due to charge are not symmetrical about the isoelectric point, and that H-bonding involving the ionic groups must also play a part. He inclines to the view that the 'unmasking' of titratable groups, first observed by the writer in the titration of edestin and studied in detail by Steinhardt in the case of hæmoglobin, is due primarily to a change in the apparent pK of ionizable groups, induced by a change of charge density due to unfolding. The expansion of a protein in this way may be an entirely reversible process, and the molecule, if treated sympathetically, may regain its configuration and solubility at the isoelectric point. The rate of return, however, is often slow, and may compete with the tendency of the expanded molecule to become aggregated and precipitated, that is, 'denatured'.

Ultimately, one hopes that the biochemist's approach to structure will be complementary to that of the X-ray crystallographer. J. C. Kendrew and M. F. Perutz discussed the value of the isomorphous replacement method, in which heavy-metal compounds or metal atoms have been introduced into myoglobin and hæmoglobin at a few selective sites. The two-dimensional Fourier projections at 6 A. resolution are virtually uninterpretable, but the three-dimensional projection at 6 A. of myoglobin begins to show rivulets of electron-dense material consistent with the gross morphology of polypeptide chains. Mrs. D. C. Hodgkin remarked that even a resolution of about 2 A. would be insufficient to resolve individual atoms, though it would suffice to disclose the general topography of some of the side-chains.

Chemical variation and biological activity. By studying the variations in primary structure of a given type of protein, either within a species or between species, important information can be gathered about the essential or dispensable parts of the polypeptide chain. H. Tuppy described how, in the case of cytochromes (where no microheterogeneity occurs), the peptide sequence of seven amino-acids around the half-cystine residues, which are linked covalently to the porphyrin group, is the same in ox, pig, horse and salmon. In the chick, serine replaces alanine, and in the silkworm, arginine replaces lysine; but in all, the span of two amino-acids between the cysteine residues allows a model to be built on the plan of an α-helix, in which the imidazole residue is able to bond with the metal of the protohæm.

Many abnormal hæmoglobins have hitherto been characterized in relation to a specific disease and by physical methods. Those responsible for sickle cell- and Hb-*C*-anæmia arise by a mutation in the locus for normal adult hæmoglobin. V. M. Ingram has compared the three forms of chromatography ('fingerprinting') of the tryptic digests, and finds a difference in only one peptide fragment. The sequence —glu.glu.lys— in adult is replaced by —val.glu.lys— in sickle cell anæmia and by —lys.glu.lys— in hæmoglobin-*C* anæmia. That such a slight change can so profoundly modify the physical properties of hæmoglobin is a problem far beyond our understanding at present.

The unique phosphorylation of serine in or near the active centres of certain enzymes by di*iso*propyl phosphofluoridate allows a comparison of sequence at a specific site in very different proteins. J. A. Cohen described how the sequence —gly.asp.ser.gly.gly— of chymotrypsin is replaced by —gly.glu.ser.ala.gly— in liver aliesterase. The substitution of similar side-chains, that of glu for asp and ala for gly, might imply that these are essential to the configuration of the active centre.

Activation of zymogens. The proteolytic enzymes are often secreted as inactive precursors which are converted to a functional form by a limited proteolysis. The schools of H. Neurath and of P. Desnuelle have greatly clarified the detailed events of these activations; but whether the active centre is created in the process, or simply revealed by unmasking, is still a matter for speculation. In trypsinogen, the liberation of one acidic hexapeptide from the N-terminal end produces the active enzyme. Desnuelle reported that the active split of this bond is accelerated by calcium ions, which at the same time

suppress a more extensive proteolysis. Chymotrypsinogen can give rise to several chymotrypsins: a tryptic split at 1 in the sequence —leu.[2]ser.arg.[1] ileu.val— gives an active form (π), and a second split at 2 by chymotrypsin itself gives the δ-form. Further splitting by chymotrypsin at 3 and 4 in the sequence —tyr.[4]thre.asp.[3]ala— produces the classical α-form of Kunitz. Desnuelle has shown that it is possible to start in reverse and in complete absence of trypsin to cleave by the action of chymotrypsin the links at 2, 3 and 4 above to give modifications ('neochymotrypsinogens') which are still enzymically inactive.

Other activations involve quite extensive proteolysis. Recent work of Neurath's group shows that Anson's crystalline carboxypeptidase is in reality only one-third the molecular weight of the zymogen, the rest being lost as dialysable fragments. Miss G. E. Perlmann reported that, by the action of urea, pepsin itself can lose dialysable components, leaving a portion with increased specific activity. This finding again is relevant to the 'junk' hypothesis.

Virus structure. Advances with respect to the structure of tobacco mosaic virus were discussed by H. Fraenkel-Conrat, G. Schramm and Miss R. E. Franklin. An unexpected discovery of recent years is that the ribonucleic acid alone, in absence of protein, is infective; another, that the sub-units of molecular weight 18,000 can be reconstituted to form the giant virus particle either in the absence of, or in the presence of, the nucleic acid component. This finding should greatly assist the elucidation of the topographical relation of nucleic acid and protein. Fraenkel-Conrat reported a feature of more general importance in protein chemistry—that the N-terminal residue (serine) of the sub-unit is substituted by an acetyl group. The indirect evidence for cyclic chains in proteins, resting as it does on the apparent absence of C- and N-terminal groups, becomes, by this and other examples (cf. α-melanophore-stimulating hormone below), of less and less significance.

Methods. The new methods which have been used so successfully for the separation of proteins, large and small peptides, and amino-acids were discussed by A. Tiselius, J. Porath, J. Borman, S. Moore, F. Turba, F. Šorm and B. Keil. In addition, L. C. Craig described a new and very simple microdiffusion apparatus which can be used not only for fractionation of dialysable peptides, but is also capable of giving information on the heterogeneity of the solute.

In retrospect, the Paris conference very clearly emphasized the great rewards that have accrued from the application of new and novel methods, and justifies the belief that any discussion of methodology should not be confined to a special symposium, but related over a very wide field to the major advances which have been made in our knowledge of the protein molecule.

KENNETH BAILEY

NEWS and VIEWS

Photograph of the Track of the Artificial Earth Satellite

THE Russian artificial Earth satellite is accompanied in its orbit by the remains of the last stage of the rocket from which it was launched. The rocket is at present travelling ahead of the satellite, at a distance which is increasing with time as the relatively greater resistance encountered by the rocket from the Earth's atmosphere causes it to fall to a lower altitude than the satellite. A photograph of the rocket, which is larger and more easily seen than the satellite itself, was taken at Hobart, Tasmania (42° 54′ S., 147° 20′ E.), at approximately 0938 G.M.T. on October 7, by Mr. T. McMahon, head of the Photographic Section in the University of Tasmania, working with members of the Department of Physics. Prof. A. L. McAulay, of the University of Tasmania, writes: "It shows the track of the rocket (Fig. 1) travelling approximately south-south-west to north-north-east against a background of stars of the constellation Aquarius".

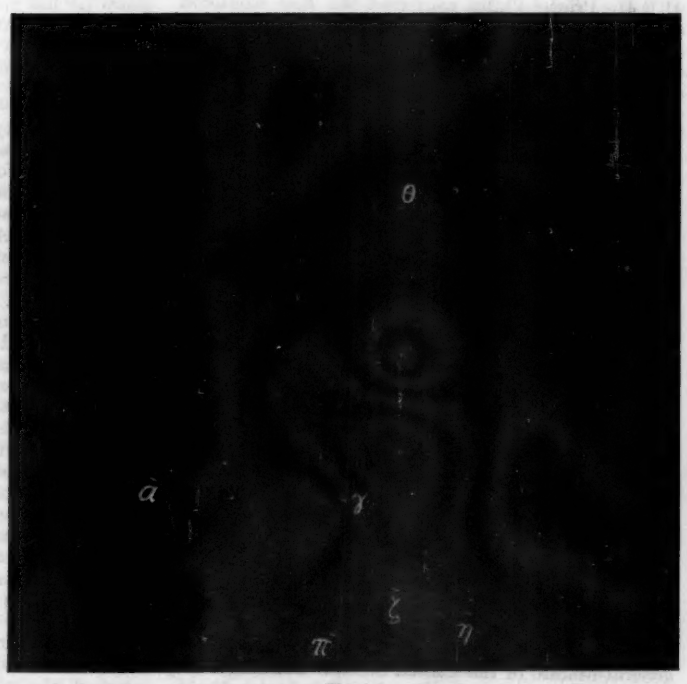


Fig. 1

Crystallography at the Swiss Federal College of Technology: Prof. J. D. Dunitz

Dr. J. D. Dunitz, who has been appointed to a chair of crystallography at the Swiss Federal College of Technology, Zurich, has had a distinguished career in the field of crystal and molecular structure studies. After graduating with first-class honours in inorganic and physical chemistry at Glasgow in 1944, he joined the research team of Prof. Monteath Robertson and carried out some very accurate structure determinations on the acetylene dicarboxylic acids. Later at Oxford, with a Carnegie Senior Scholarship, and at Pasadena, with an A. A. Noyes Fellowship, he extended his work to more complex organic compounds including certain important antibiotics. While holding later appointments at the National Institutes of Health, Bethesda, and at the Royal Institution in London, he has continued to make contributions to the field of complex natural products and proteins. Dr. Dunitz's interests, however, are not confined to these problems of complex structures, and he has made several important contributions to the structural chemistry of simple inorganic molecules, and in collaboration with Dr. Orgel he has written a number of important theoretical papers. These deal with the effect of chain-length on symmetry of conjugated molecules, with the stability and structure of the molecular sandwich compounds (dicyclopentadienyl iron) and other topics. In his new and important post at Zurich Dr. Dunitz will have ample opportunity to enlarge and extend his many interests in modern structural chemistry and crystallography.

American Institute of Physics: Compton Gold Medal

On behalf of the American Institute of Physics, H.R.H. Prince Philip conferred the first Compton Gold Medal of the Institute on Dr. G. B. Pegram, vice-president emeritus of Columbia University, for distinguished service to physics. The ceremony, which occurred in conjunction with the dedication of the new building of the American Institute of Physics at 335 East 45th Street, New York (see *Nature*, 179, 1167; 1957), was held before a group of distinguished scientists, educators and administrators in the Karl Taylor Compton Memorial Room of the new Institute on October 21. Dr. Pegram was a founder member of the American Institute of Physics in 1931, together with the late Dr. K. T. Compton and others. He served as its first secretary for fourteen years and was treasurer for eighteen years until he retired last year. Dr. Pegram also was an officer of the American Physical Society for thirty-eight years, serving as president and treasurer. He made the first contact with the United States Government in March 1939 which resulted in the Manhattan Project, after J. R. Dunning and the late Enrico Fermi had demonstrated the release of energy by uranium fission at Columbia University.

Dr. S. Fred Singer

Dr. S. Fred Singer, associate professor in the Department of Physics, University of Maryland, is to receive a United States Junior Chamber of Commerce award as one of the ten outstanding young men of the year 1957 whose achievements have been of importance in their professions and also to the general welfare of the United States. Dr. Singer has contributed to the study of rocketry and astrophysics as the leader in design and development of three small, inexpensive rockets for upper-atmosphere research. These are the 'Rockaire', the first high-altitude research rocket launched from aircraft; the 'Terrapin', the smallest high-altitude rocket launched from the ground; and the forthcoming 'Oriole', a ground- or ship-launched rocket which will be even less expensive and smaller. Dr. Singer has completed the design and construction of instruments for the detection of cosmic rays, to be installed in rockets to be fired in the current 'Far Side Project'.

President of the Royal Australian Chemical Institute: Dr. I. W. Wark

Dr. I. W. Wark, chief of the Division of Industrial Chemistry of the Commonwealth Scientific and Industrial Research Organization, has been elected general president of the Royal Australian Chemical Institute for 1957–58. Dr. Wark has been chief of the Division of Industrial Chemistry since its formation in 1940. Under his guidance this laboratory has grown until it now has a research staff of one hundred. Among its achievements are the process using cetyl alcohol for controlling evaporation from dams and reservoirs and a method for separating hafnium from zirconium which is of significance for atomic powered submarines. Dr. Wark's own personal research was concerned with the theory of the flotation process for separating minerals from ores. His pioneering work as a physical chemist in this field gained for him a wide reputation and his book "Principles of Flotation", first published in 1938, became recognized as a classic on the subject. He graduated at the University of Melbourne and continued his postgraduate studies at the Universities of London and California. Dr. Wark is a Fellow of the Australian Academy of Science. For many years he has taken a prominent part in the affairs of the Royal Australian Chemical Institute and has done much to gain a wider appreciation of the importance of chemistry and of science generally.

A Regional Museum Service

About twenty-five years ago the museums and art galleries of Great Britain were grouped together on a regional basis for friendly advice and help. It was a type of unofficial co-operation and each member of a group or federation was completely autonomous but could rely on fellow-members for help if desired. The Museums Association now considers that this service should be placed on a more regularized basis and proposes as an experiment to endeavour to set up a regional museum service in the south-west of England. It is considered that such a service would be helpful in the identification of material, the conservation of objects, and the organization of work with the schools. As a first step towards the initiation of such a service a meeting of local authorities and other interested bodies was held at Taunton on October 15 under the chairmanship of Sir Mortimer Wheeler. The meeting was enthusiastic concerning the value and worthwhileness of such a scheme and the only doubts raised were those involving finance. After careful consideration of the factors involved, it was decided to form a committee of inquiry consisting of four representatives of the county councils, four from the municipalities, four from the South-Western Group of Museums and Art Galleries, two from the Museums Association and one from the universities within the area of the counties of Bristol, Cornwall, Devon,

Dorset, Gloucestershire, Monmouthshire, Somerset and Wiltshire. This committee was duly elected and requested to report back as soon as possible.

Annual Relief Voyage of R.R.S. *John Biscoe*

THE R.R.S. *John Biscoe* left Southampton on October 21 on her annual relief voyage to the Antarctic with staff and supplies for the Falkland Islands Dependencies Survey. The Survey maintains eleven permanent bases along the coast of Graham Land and on islands off the coast. Eighty or so scientists and technicians spend periods ranging from a year to two years at the bases, carrying out surveys, scientific research and meteorological work. Each Antarctic summer, between November and March, the ice of the Antarctic clears sufficiently for specially strengthened ships to make the voyage to the bases with relief staff, supplies and equipment. The present R.R.S. *John Biscoe* was built for this work. On her way to Port Stanley, she will call at St. Helena and Tristan da Cunha.

Bibliography on Atomic Energy

A MOST useful bibliography of sources of information on atomic energy taken from a paper (*A.E.R.E.* Lib/Ll) is given in *Atom* (No. 7, 23 ; May 1957), the monthly information bulletin of the U.K. Atomic Energy Authority. The bibliography covers publications on the work of the Authority ; lists issued by the Authority ; general bibliographies ; four abstract journals ; fourteen British and Commonwealth, nine American, and eight European periodicals and translated versions of Russian periodicals. A more limited bibliography (*A.E.R.E.* Inf/Bib 100. Harwell : Information Office, A.E.R.E., Harwell), which has recently been reprinted with additions, lists books published in Great Britain on nuclear energy, nuclear and atomic physics, the measurement of radioactivity, isotopes, and some related topics. It includes both popular expositions and advanced texts written for the specialist, in addition to periodicals in the field of nuclear energy.

Research in Central Africa

THE seventh annual report of the Institute for Scientific Research in Central Africa (pp. 268. Bruxelles : Institut pour la Recherche Scientifique en Afrique Centrale, 1956) covers the year 1954 and, besides the Director's report and accounts showing expenditure of some 77 million francs, of which 50 million were spent on research at the various research stations, it includes a review by I. H. Vincke of the anti-paludism campaign in Africa south of the Sahara and summaries of papers published during the year by the staff or research workers associated with the Institute. The report records a major study of certain depopulated districts undertaken at the request of the Government of Ruanda-Urundi to determine the facts for a campaign against *Glossina* responsible for the trypanosomiasis causing the depopulation. Collection of anastomopathological material for neuropathological studies with reference to virus diseases continued at Lwiro, where work on nutrition expanded considerably, particularly biochemical studies on proteins and amino-acids in relation to the nutrition of native children. Observations on birds in the neighbourhood of Tshibati and Lwiro continued, and at Uvira on Lake Tanganyika extensive studies were made of ndekala, a pelagic fish intensively fished in Tanganyika. Besides numerous hydrological observations on the temperature and composition of the water of the lake at various depths, many purely geographical observations were made relatively to its depth in the region of affluents, seasonal variations in temperature, lacustra, etc. Solar observations also continued at Lwiro as well as ionosphere observations and measurements of solar radiation.

The Rings and Satellites of Saturn

IN a recent paper entitled "The Effect of the Saturnian Ring upon the Motion of the Satellites" (*Publ. Astro. Soc. Japan*, 8, No. 1 ; 1957), Yoshihide Kozai starts with the assumption that the ring-system of Saturn, composed of a number of small solid particles, consists of two concentric rings with uniform thickness and density, and then proceeds to determine the quantitative effect of the ring on the motion of the satellites. The *A*-ring is supposed to be limited by the radii of 20·02″ and 17·49″, seen at the mean least distance, and the limits of the *B*- and *C*-rings are placed at the distances 16·90″ and 10·49″. Observational data are presented for comparison with the theory, and the values of the mean motions are computed on the assumption that $k/a^3 = 0{\cdot}024305$, $1/a^4 = 0$ for the six inner satellites of Saturn. From the solution of the normal equations it seems probable that the mass of the ring is of the order 10^{-4} that of Saturn. The precessional motion of the axis of rotation of Saturn is too slow to be detected, even from observations over about a century.

National Science Foundation Fellowships

THE U.S. National Science Foundation is offering four types of fellowship awards for advanced study and research in the natural sciences during the academic year 1958–59 : predoctoral fellowships for college seniors and graduates (1,600–2,000 dollars a year) ; postdoctoral fellowships (3,800 dollars) ; senior postdoctoral fellowships for candidates who have held a science doctorate for a minimum of five years (up to 10,000 dollars) ; and science faculty fellowships for college teachers of science who wish to improve their competence as teachers (up to 10,000 dollars). The awards are open to American citizens and are tenable at any non-profit-making institution of higher education in the United States or abroad. Fellowships will be awarded in the mathematical, physical, medical, biological, engineering and other sciences, including anthropology, psychology (other than clinical), geography, certain interdisciplinary fields, and areas of convergence between the natural and social sciences. About a thousand awards will be made, to be announced next March. Fellows will be selected on the basis of ability assessed from letters of recommendation, academic records and other evidence of attainment. Applicants for the predoctoral fellowships are required to take the Graduate Record Examination. Forms of application for predoctoral fellowships, which must be completed by January 3, 1958, and for postdoctoral fellowships, which must be completed by December 23, 1957, may be obtained from the Fellowship Office, National Academy of Sciences—National Research Council, 2101 Constitution Avenue, N.W., Washington 25, D.C. Forms of application for senior postdoctoral and science faculty fellowships, which must be completed by January 13, 1958, may be obtained from the Division of Scientific Personnel and Education, National Science Foundation, Washington 25, D.C.

Gas Chromatography Symposium

The second symposium on "Gas Chromatography" will take place at the Tropical Institute, Amsterdam, during May 19–23, 1958. The meeting is being organized by the Gas Chromatography Discussion Group under the auspices of the Hydrocarbon Research Group of the Institute of Petroleum, and the Koninklijke Nederlandse Chemische Vereniging. It is intended that the programme shall be divided into three sections: *A*, theoretical; *B*, apparatus and techniques; *C*, applications. The official language at the symposium will be English. Original contributions and a 250 word abstract (two copies) should be submitted to the Secretary before November 20. Those papers describing applications of the techniques should have some novel feature. Application for registration must reach the Secretary before March 1, the fee being approximately 45 guilders, which will include the cost of preprints and receptions. Fur information can be obtained from the Secret G. Dijkstra, Unilever Research Laboratory, Veersingel, Vlaardingen, Netherlands.

Bedson Club

The thirty-first annual general meeting of the Bedson Club, King's College, Newcastle on Tyne, was held on October 18. The programme of Bedson Lectures during 1957–58 will be: November 1, Dr. Dorothy Crowfoot Hodgkin, "The Structure of Vitamin B_{12}"; November 22, Prof. A. J. Birch, "Recent Studies in Relation to Biosynthesis"; January 31, Dr. J. W. Linnett, "The Structure of Flames"; March 7, Dr. H. Seligman, "Use of Radioactive Materials in Industry".

The Night Sky in November

Full moon occurs on November 7d. 14h. 32m. U.T., and new moon on November 21d. 16h. 19m. The following conjunctions with the Moon take place: November 19d. 03h., Jupiter 3° N.; November 25d. 14h., Venus 8° S. In addition to these conjunctions with the Moon, Mercury is in conjunction with Antares on November 17d. 13h., Mercury being 2·7° N., Jupiter with Spica on November 21d. 17h., Jupiter being 3·4° N., and Mercury with Saturn on November 21d. 21h., Mercury being 3·6° S. There will be a total eclipse of the Moon on November 7, invisible at Greenwich. Mercury is too close to the Sun for observation. Venus sets at 18h. 20m., 18h. 35m. and 18h. 55m. at the beginning, middle and end of the month, respectively; during this time its distance from the Earth decreases from 75 to 53 million miles, the visible portion of the apparent disk from 0·578 to 0·428, and its stellar magnitude from − 3·9 to − 4·2. It is a brilliant object in the south-west after sunset; greatest eastern elongation is on November 18. Mars rises at about 5h. 40m. throughout the month; it is visible in the south-east just before sunrise. Jupiter rises at 4h. 55m., 4h. 20m. and 3h. 35m. at the beginning, middle and end of the month, respectively; it is near Spica. The stellar magnitude of Jupiter is − 1·3, its distance from the Earth on November 15 being 585 million miles. Saturn appears too close to the Sun for observation. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: November 9d. 19h. 13·9m., 97 Tau. (*R*); November 14d. 0h. 24·7m., A^2 Cnc. (*R*); *R* refers to reappearance. The Taurid meteors are active during November 1–10 and the Leonids during November 15–17, but conditions are not favourable for observation.

Announcements

Dr. A. D. Merriman, who has been registrar-secretary of the Institution of Metallurgists for the past ten years, is to retire at the end of this year. He will be succeeded on January 1, 1958, by Mr. R. G. S. Ludlam, who has been assistant registrar in the University of Leeds since 1951.

The Faraday Society Bourke Lectures will be given by Prof. W. Jost, of the University of Göttingen. The lectures are: "Reactions in Detonations and Shock Waves", to be given in the Lecture Theatre of the Department of Physical Chemistry, University of Cambridge, Free School Lane, on October 28, at 4.30 p.m. (chairman, Prof. R. G. W. Norrish); "Flame Reactions", to be given in the Lecture Theatre, Inorganic Chemistry Laboratory, South Parks Road, Oxford, on October 31, at 5 p.m. (chairman, Mr. R. P. Bell); and "Crystal Defects, especially near Phase Transitions", to be given in the Main Lecture Theatre, Chemistry Department, the Imperial College of Science and Technology, London, on November 4, at 5 p.m. (chairman, Sir Eric Rideal).

The autumn meeting of the British Society for Immunology will be held at the Wellcome Foundation, 183 Euston Road, London, during November 15–16. The first day will be devoted to a symposium on "Immuno-hæmatology" from 10 a.m. (chairman, Prof. J. V. Dacie).

The Institute of Physics (London and Home Counties Branch) has organized a Symposium on "The Design of Physics Research Laboratories" to be held at 2.30 p.m. on November 27 in the Lecture Theatre of the Royal Institution, 21 Albemarle Street, London, W.1. Admission is by ticket, obtainable from the Institute of Physics, 47 Belgrave Square, London, S.W.1, to which all inquiries should be made.

The Institute of Biology is arranging a second international symposium on "Freezing and Drying", which will be held in the Beveridge Hall, Senate House, London, W.C.1, on April 1 and 2, 1958. Further information can be obtained from the Secretary, Institute of Biology, 41 Queen's Gate, London, S.W.7.

The Eighth Canadian High Polymer Forum will be held at MacDonald College, Quebec, Canada, during May 12–14, 1958. The meeting is sponsored by the National Research Council of Canada and the Chemical Institute of Canada and will cover all aspects of polymer science. Further information can be obtained from Dr. L. A. McLeod, Research and Development Division, Polymer Corporation, Ltd., Sarnia, Ontario, Canada.

At the annual general meeting of the British Society of Rheology, held at the University College of Swansea on September 19, the following elections were made for the year 1957–58: *President*, Prof. E. G. Richardson; *Hon. Secretary*, Mr. N. Wookey; *Hon. Treasurer*, Mr. D. W. Jopling; *Hon. Editors*, Dr. E. W. J. Mardles and Dr. J. C. Vernon; *New Members of the Committee*, Dr. M. F. Culpin, Dr. A. Jobling and Mr. G. H. Tattersall. Information concerning the Society can be obtained from the Hon. Secretary, 52 Tavistock Road, Edgware, Middlesex.

SOIL MECHANICS AND FOUNDATION ENGINEERING

FOURTH INTERNATIONAL CONFERENCE

PERHAPS the most outstanding development in modern civil engineering practice has been the remarkable growth in the science of soil mechanics during the past thirty years. The publication in 1925 by Prof. Karl Terzaghi of his book "Erdbaumechanik auf Bodenphysikalischer Grundlage", in which he described his researches into the consolidation and shear strength of soil, is generally regarded as marking the beginning of the scientific study of soil as material of engineering interest. There followed a period of increasing interest in the subject, evidenced in Great Britain by the establishment in 1933 of a soil mechanics laboratory at the Building Research Station at Watford, Hertfordshire.

The year 1936 marked an important stage in the development of this new science, since in that year the first international conference was held at Harvard University, and this led to the formation of the International Society of Soil Mechanics and Foundation Engineering, with Prof. Terzaghi as the first president.

Since the end of the Second World War the International Society has gone from strength to strength, and there are now thirty countries represented in the Society as well as many private members from other countries. Following successful conferences at Rotterdam in 1948 and at Zürich in 1953, the largest and most successful, the fourth, took place in London during August 12–24 at the Institution of Civil Engineers, at which some 750 delegates were present.

Following the opening of the Conference by Sir Arthur Whitaker, president of the Institution of Civil Engineers, Prof. Terzaghi delivered an address to the Conference in which he developed the theme of his opening speech to the Zürich Conference, namely, that the application of soil mechanics to civil engineering problems, in spite of the advances in the knowledge of the properties of soils, will never be a matter of precision because of the variability in the properties of soils occurring in most strata, and must ultimately depend upon the skill and imagination of the engineer.

Some 189 papers were submitted, and in the light of experience gained at previous conferences these were placed into six divisions: (1) soil properties and their measurements; (2) techniques of field measurement and sampling; (3) foundations of structures; (4) roads, runways and rail-tracks; (5) earth pressure on structures and tunnels; (6) earth dams, slopes and open excavations.

There were nine technical sessions each of three hours duration, two being devoted to the subject-matter of division 1 and three to that of division 3, in view of their especial interest. Each session followed a similar course in which a general reporter opened the proceedings by summarizing the main conclusions he had drawn from reading the papers contributed to the particular division with which he was concerned, and he was followed by individual contributors to the discussion of the papers by members of the Conference. On the whole, the discussions were of a high standard and very stimulating, as was demonstrated by the high level of interest maintained by members throughout the week and a half of what must be admitted to have been a somewhat exhausting programme.

It was abundantly clear from the Conference that soil mechanics has a major part to play in civil engineering developments throughout the world, and it is natural that a considerable growth of interest in the subject is taking place in regions where there are large areas calling for development, as, for example, in Canada and the U.S.S.R.

The great increase in the amount of construction of high multi-storied buildings and other large structures has resulted in a corresponding growth of interest in the design of the foundations to carry heavy loads. Useful progress was reported in the development of methods of estimating the ultimate bearing capacity of foundations, but especial interest was shown in the problem of making accurate estimates of the settlement of structures founded on clays and other compressible soils. It appears that in spite of the many assumptions made in the method of estimating settlements based on Terzaghi's theory of consolidation, reasonably satisfactory agreement between the calculated and actual settlements is usually obtained for normally and lightly over-consolidated clays; heavily over-consolidated clays have been shown to need a special approach. A disappointment was the absence of any significant advance in obtaining a better understanding of secondary consolidation, which is the compression phase that occurs after the dissipation of the excess pressure of pore-water created by loading the soil.

In spite of improvements in the theoretical treatment of the bearing capacity of soils, the evidence from several papers indicated that serious discrepancies can occur between the actual and calculated values. This renders important the problem of how best to introduce a factor of safety into stability analyses. It emerged that there is now general agreement that the most rational method is to use a reduced value for the shear strength of the soil.

On the subject of pile foundations, practical evidence suggests that considerable confidence can now be placed in the methods used for estimating the load capacity of piles driven through soft soils to a firm granular stratum and of piles embedded in sand, but it appears that loaded piles embedded in soft clays are liable to significant settlements over long periods of time.

Another important application of soil mechanics is to the stability of slopes. This subject embraces natural slopes, which may be affected by sudden landslides or slow creep, excavated slopes such as cuttings for railways, roads and canals, and embankments, of which the most important example is earth dams.

Members of the Conference were given a graphical reminder of the devastation that can follow from a large landslide by a description by Mr. Fellenius of the great slides on the Gotha River in Sweden. Scientific studies are now frequently made of such landslides with the object of understanding more precisely the mechanics of the process. Of especial interest was the explanation by Prof. A. W. Skempton

(Imperial College of Science and Technology, London) of the reasons why London clay assumes a natural slope of 10 deg.

It was noted that very little effort is being devoted to the problem of the stability of excavated slopes. It appears that such slopes are often initially cut at a much steeper angle than is satisfactory for stability, and where large and costly cuttings are required, as, for example, for modern highways, a greater application of the principles of soil mechanics was advocated.

A session of the Conference was devoted to a discussion of earth pressures which determine the stresses acting, for example, on the linings of tunnels and on sheet piling and other earth-retaining structures. It is now recognized that in practice some yield of the structure almost invariably takes place, and the problem is then to make a reliable estimate of the distribution of stresses on structures in terms of this yield. Useful progress on this problem was reported in respect of both sheet piling and tunnels.

The rapid growth of traffic on the roads and the increased weight of aircraft have resulted in the need for thicker and stronger foundations for road and airfield pavements. This has rendered important the need for improved methods of pavement design in order that the most economical approach may be determined with some precision. Although the papers contributed to the Conference were scarcely representative of present thinking on this subject, it appears that reliance is mainly placed on empirical methods of design in which the estimated thickness of pavement is related for particular traffic conditions to the bearing strength of the soil measured by some form of penetration or loaded plate test. However, a trend was noted towards thinking in terms of a design method based on the moduli of deformation of the soil and pavement materials.

An understanding of the factors affecting the moisture conditions in soils under pavements is important because the moisture content largely governs the strength of the soil and hence the design of the pavements. While a satisfactory solution of this problem for humid climates has been developed in terms of the suction properties of the soil, it emerged that the part played by vapour transfer under more arid climatic conditions is not yet fully understood.

Quite apart from the consideration given to the physical properties of soil during the discussion of papers presented in division 1, the Conference was repeatedly brought back, during the sessions devoted to the more practical problems of foundation engineering, to the need for a better understanding of the fundamental factors governing these properties. There is now general recognition of the need to express shear strength in terms of effective stresses, and of the importance of making pore water pressure measurements both in laboratory tests and in field studies. These conclusions are, however, of principal value in their practical application to analyses of stability problems and do not help to any great extent in understanding the bases of soil strength.

Perhaps the most encouraging development at this Conference was the emergence of a body of support for the concept that many of the observed shear properties of soils can be satisfactorily explained in terms of internal normal stresses resulting from tensions in the pore water system. It was suggested that the development of this concept may well lead to the shear strength of soil being expressed in terms of a dimensionless coefficient of friction. Papers to the Conference also indicated useful advances in attempts to explain soil properties in terms of colloid chemistry and surface physics. Perhaps it is not too much to hope that by the time the next Conference is held a satisfactory hypothesis will have been developed that explains the part played by tensions in the soil water system and at the same time relates these tensions to the surface forces resulting from the interaction of clay minerals and water.

At the closing session of the Conference, members learnt with deep regret that Prof. Terzaghi had decided to relinquish the presidency of the International Society. The new president is Prof. A. W. Skempton, professor of civil engineering at the Imperial College of Science and Technology, London. It was also learnt that the offices of the Executive Committee had been transferred from Harvard University to the Institution of Civil Engineers in London, with Mr. A. Banister as secretary to the Committee. Paris has been selected as the meeting place for the next international conference.

During the Conference a number of technical visits were arranged to government, university and commercial soil mechanics laboratories and to sites of civil engineering interest. Receptions were held at the Tate Gallery, at the invitation of the chairman and members of the Public Works and Municipal Services Congress and Exhibition Council, and at the Hurlingham Club, and the Conference concluded with a banquet held at Grosvenor House. Following the Conference, many members joined short trips to various parts of the country to see works of civil engineering interest.

D. J. Maclean

GAS CHROMATOGRAPHY

An International Symposium on Gas Chromatography, sponsored by the Analysis Instrumentation Division of the Instrument Society of America, was held at the Kellogg Center for Continuing Education, East Lansing, Michigan, during August 28–30. H. J. Noebels (Beckman Instruments) was general chairman, and the programme was organized by V. J. Coates (Perkin-Elmer Corporation). The meeting was attended by about 350 people. Formal sessions were held in the mornings and evenings, leaving the afternoons free for informal discussions by small groups. This proved to be a very happy arrangement, as it allowed those with special interests to discuss fine points at length without holding up the main proceedings; I remember in particular a very lively triangular discussion between M. J. E. Golay, A. J. P. Martin and A. I. M. Keulemans on the usefulness of the theoretical plate concept. The formal meetings consisted of invited lectures, followed by a series of short contributed papers.

A large number of papers were concerned with the application of gas chromatography to specific analytical problems, such as arise in connexion with gasolines, ester-type plasticizers, chlorofluorohydrocarbons, glycols and piperazines. Many of the speakers commented on the savings in time and money which the new technique had brought to their companies. Other papers were devoted to detailed

descriptions of apparatus and accessories (such as sampling devices and integrators), especially in connexion with commercial gas chromatographic equipment. As it is proposed to publish the full proceedings of the symposium in the near future, this report will be confined to those developments described at the symposium which seem to be of more immediate and general interest.

In the opening lecture, M. J. E. Golay (Perkin-Elmer) described his theoretical studies on the performance of a simplified gas–liquid chromatographic system, in which the liquid phase was held on the walls of a fine capillary. In such a system there should be no contribution to plate height (or peak spreading) from a channelling or 'eddy' term. Golay showed how the usefulness of such columns could be measured in terms of a 'performance index' (*Nature*, 180, 435; 1957), in which the drop in pressure across the column and the time for analysis are included as the price paid for sharpness of the peak. An account was given of some experimental work which had been undertaken to test the theory. The results were also of great practical interest, in that sharp separations (equivalent to about 10,000 plates) had been obtained with simple columns. Furthermore, it was found possible to run capillary columns extremely rapidly.

The behaviour of solid support materials was discussed by T. Johns (Beckman Instruments), and E. A. Hinkle and S. E. J. Johnsen (Monsanto Chemical Company, Texas City) showed how peak areas (using a thermistor detector) could be converted to molar concentrations by the use of vapour densities as correcting factors. C. S. G. Phillips (Oxford) described work using metal salts (in particular, zinc and copper stearates and nickel oleate) as column liquids. He pointed out that the strong forces between metal atoms and the ligand (solute) molecules made possible new types of separation. Changes in relative retention times up to several thousandfold in favourable cases (as, for example, with amines) could be obtained by this method. Such changes were also of value for the characterization of solute substances. He showed how the results with the metal salts columns could be related to studies of complex ion formation in aqueous solution, and how gas chromatography might thus be used for studying complexing equilibria. The use of gas chromatography in kinetic studies of the isomerization of geometrical isomers, the thermal decomposition of acetylene and the thermal decomposition of light hydrocarbons was discussed by L. F. Hatch (University of Texas), and in the study of the hydrogenation products of benzene by R. E. Rippere (General Electric Co.).

H. R. Felton (du Pont, Wilmington, Delaware) described a novel and compact high-temperature gas chromatography unit, in which the detector was a thermal conductivity cell using model-aeroplane glow-plugs. Sensitivity and response data for the unit were given from 40° C. to 550° C., and its use was illustrated by analyses of the fluoroesters of camphoric acid (boiling points 320° C.–460° C.), the α- and β-N-phenylnaphthylamines and the toluene isocyanates. The factors affecting the selection of thermistors for use in katharometers formed the subject of a useful study by P. H. Stirling and C. B. Cowan (Canadian Industries, McMasterville, Quebec), who stressed the importance of matching thermistors for resistance, resistance change with temperature and for dissipation constant. A copper oxide combustor as a means for increasing detector response was discussed by S. Norem (Perkin-Elmer).

One session and an invited lecture by B. O. Ayers (Phillips Petroleum) were devoted to the use of gas chromatographic instrumentation for continuous automatic analysis. Two commercial instruments (Perkin-Elmer and Leeds-Northrup) were described in some detail in the contributed papers. Ayers pointed out that a number of analysers were now available commercially, and that these instruments compared most favourably with other types of automatic analysers, especially in the wealth of data which they make available at a relatively low cost for the instrument. He described the testing of the Perkin-Elmer instrument on typical plant problems.

In a stimulating and entertaining after-dinner speech, A. J. P. Martin described his early work on separation techniques, in association with R. L. M. Synge and later with A. T. James, which led up to the discovery of gas–liquid chromatography. He commented on present trends in the field, the influence of gas chromatography on other techniques and its many possible applications. He concluded with some suggestions for the future of the method, including the development of the completely automatic analyst.

C. S. G. PHILLIPS

MACROMOLECULAR CHEMISTRY

INTERNATIONAL SYMPOSIUM

THE Macromolecular Commission of the International Union of Pure and Applied Chemistry broke entirely new ground this year by holding the tenth Symposium, on "Macromolecular Chemistry", in Prague. The success of this penetration into Central Europe and, for the Western countries, behind the Iron Curtain, is reflected in the record number of active participants housed in the Hotel International in the outskirts of the city in which the meetings, except for the opening session, were also held. This procedure lent an air of informality to the proceedings and, by keeping all participants in intimate contact with one another, fostered a feeling of friendly co-operation throughout the week.

No praise is high enough for the diligence, care and thoroughness with which the Organizing Committee, under the leadership of Prof. O. Wichterle, had laid its plans. Almost all the 200 papers and lectures were available in preprint form (Russian and Czech manuscripts were translated into English). To overcome the language difficulty still further, a very efficient cabinet translation service was in continuous session during the presentation of lectures and papers. All delegates were supplied with 10-channel transistor receiver head-sets which carried the translation service in Czech, Russian, French, English and German. This very fine piece of organization was much appreciated by all who took part and removed most of the strain of following complicated argument in a foreign tongue.

The matter of the Symposium was divided into two large sections dealing with (*a*) physics and physical chemistry of macromolecules and (*b*) polyreactions. These broad units were subdivided into smaller sections each dealing with a group of related problems in the field. The proceedings were initiated with a lecture by Prof. Paul Doty on "Biological Polymers".

This took the form of an exemplary review of the field to which the lecturer has made so many outstanding contributions. In the second Symposium lecture, Prof. H. Mark (Brooklyn) related with his usual enthusiasm and vigour the progress in polymer research and technology in the past year. His close contacts with the industrial and academic sides in the United States always make his lectures of very great interest and importance to European audiences.

Each of the sectional meetings was introduced by a lecture on a specific problem on the field. These lectures were later open to discussion, a feature which was novel to the Symposium but produced much of interest and importance. Both lectures and discussion are to be published in *Chemické Listy* and in *Collection of Czechoslovak Chemical Communications*. Prof. A. Peterlin (Ljubljana) introduced the group discussing statistics, thermodynamics and kinetics, with a lecture on the excluded-volume effect on the properties of macromolecules in solution. The properties of macromolecules in solution have long been the province of the Strasbourg school, so that it was fitting that the two sessions of this section were addressed respectively by Prof. H. Benoit, on the problems posed by polydispersity and molecular anisotropy in light scattering, and by Dr. R. Cerf, on the flow birefringence of macromolecular solutions. Prof. A. V. Kargin (Moscow), who dealt with structure and phase-state of polymers, discussed in detail the results of electron and X-ray diffraction and electron microscopy studies of 'Terylene', polytrifluorochloroethylene polyethylene, nylon and caprolactam polymers. Prof. F. A. Müller (Hamburg) in the same section concentrated on the deformation behaviour of polymers, especially under great deformation.

The biggest of the smaller sections dealt with the subject of radical addition polymerization, to which four sessions were allotted. In the first of these Prof. S. S. Medvedev (Moscow) gave a critical review of the present ideas of the mechanism of emulsion polymerization, a topic on which his own views tend to be at variance with the generally accepted theory of Smith and Ewart. Prof. G. V. Schulz (Mainz) described, in detail and with numerous illustrations, the use of polymerization as a test reaction for investigating the kinetics of radical reactions. In recent years the use of high-energy radiation, particularly gamma-radiation, has been exhaustively investigated as a method of initiating polymerization. It was particularly fitting that Prof. M. Magat (Paris), a pioneer in this field, should open the session dealing with this type of work. The problem of the kinetics of high-conversion reactions was treated by Prof. G. M. Burnett (Aberdeen), who reviewed past work and suggested an empirical approach which appeared to fit the experimental data. The section dealing with ionic mechanisms was addressed by Dr. D. C. Pepper (Dublin), who analysed in critical detail the various steps in the polymerization process and directed attention to the importance of ionic intermediaries in the polymerization of cyclic imines and oxides. Under the heading of other mechanisms of polymerization Prof. K. Zeigler (Mullheim) and Prof. F. Danusso (Milan), respectively, spoke on the use of organometallic compounds in the production of high polymers and on the kinetics of stereospecific polymerization. These papers occasioned much discussion, thereby underlining the wisdom of choosing specifically this field for the next Symposium, to be held at Nottingham in 1958.

The contribution of the host country was made by Prof. O. Wichterle (Prague), in a discussion of the polymerization of caprolactam which included valuable remarks on likely future trends. Prof. R. Simha (New York) tackled the extremely difficult task of attempting a unified hypothesis to explain the great divergences encountered in the pyrolysis of macromolecules. He approached the problem along the lines he has already successfully exploited, and was able by extension of previous methods to put forward convincing conceptions of the mechanism of the reaction. Interaction of polymeric molecules with organic reagents has for long been neglected but, with the rise of the importance of achieving modifications in the shape of graft and block copolymers, this field has now become more widely recognized. Under this heading Prof. W. Kern (Mainz) and Prof. G. Smets (Louvain) contributed interesting and valuable reviews of the current situation. Somewhat strangely in the context of so much discussion of synthetic polymers, the reactions of natural macromolecules such as proteins, nucleic acids and polysaccharides were considered. This section was introduced by Prof. H. Morawetz (New York), who concentrated on some specific effects encountered in polyelectrolyte solutions. The high density of charge along the macromolecule is of great moment in elucidating many of the effects of complexing with counter ions and the like. The extension of such observations from the synthetic to natural polyelectrolytes is likely to be very important. A new section in the symposium was devoted to the inorganic high polymers. The lecturer in this section, Prof. E. Thilo (Berlin), considered in particular the phosphates and silicates. Indeed, most of the section contributions tended to be directed towards these compounds.

Within the compass of a brief review such as this it is not possible to consider, even in passing, the many contributions to the proceedings, nor is it feasible to attempt an objective selection of the more important papers. Altogether some 180 papers were presented, and it is indicative of current lines of investigation to consider these under group headings. The largest groups were those dealing with solutions (34 contributors) and with radical polymerization (30 contributors). Properties of gels, melts and solids, and condensation polymerization (including ring monomers), each claimed 24, and natural large molecules, including proteins, nucleic acids and polysaccharides, had 29 contributors. The remaining groups obviously had few contributors, but in common with the more popular sections the standard of the contributions themselves and also of the ensuing discussion was high.

On a national level the distribution of papers is equally interesting. Contrary to expectation, perhaps, the leading nation was Germany (taking East and West Germany together) with 40 contributions, followed by the U.S.S.R. (31); France (28); Czechoslovakia (25); the United States (17) and Great Britain (16). At the same time the number of papers submitted does not reflect the actual attendance at the Symposium since, for example, the 150 Russians present formed the biggest single group. They were led by Prof. N. V. Semenov, who contributed some interesting observations in discussion.

Outside the conference halls the hospitality of the hosts left nothing to be desired. After the lengthy sessions of the day, entertainment in the evenings was lavish and spectacular, with a deliberate

flavour of national pride. Alternative entertainment was normally provided, also showing the culture of the country. The high-lights of the week were probably the performance of Dvorak's "Rusalka" in the National Theatre and the traditional Symposium dinner in the Wallenstein Palace.

In retrospect one can sum up the Symposium as being one of the most successful yet held and certainly the best organized. The standard which was set is one which will be found difficult to equal, but it is hoped that something approaching this technical perfection will be reached in other countries, both west and east of the Iron Curtain, in future international symposia.

THE LIBRARY ASSOCIATION

ANNUAL CONFERENCE

IN his presidential address to the Library Association on September 17 on the theme of "Knowledge and Education", Dr. J. Bronowski said that a civilized society must preserve what its best minds discover, but preservation alone does not make it an educated or even a cultured society. Moreover, an educated society could exist only when knowledge is not merely stored but is also shared, and it was the invention of printing that made the book an instrument of education. Dr. Bronowski drew on his own experience to illustrate the role that libraries can take in education and above all in self-education, but in science the public libraries have scarcely played that part at all: if they are to do so, they must have the books to enable them to make the language of science familiar to those who are not professional scientists. Besides the classics of literature, we need many more new classics of science—books like those of Sherrington, Eddington and Schrödinger, which looked at new discoveries in a personal way and spoke to the non-scientist through their personal tone and philosophy. He urged the publication of the old and new classics of science in a single series, which he believed would be widely bought and read and would make the language of science familiar to a new generation, showing them the concepts of science for what they are, classical creations which rank among the permanent monuments to the human imagination. He did not think that the printed book was the last instrument of education we would discover, but he was sure that the printed book and the public library would remain the most powerful means for self-education.

Dr. Bronowski's address found echoes in several of the addresses which followed. Mr. A. Shaw Wright's review of the thirty years work of the County Libraries Section of the Library Association, in referring to the work of the regional bureaux, to the "Readers' Guides", to the international exchanges of assistants and the help of the Carnegie United Kingdom Trust, indicated also the way in which the county libraries contributed to this work of self-education. It was implicit also in the discussion of the problems of the school library which Mr. E. Blishen introduced under the title "The Reluctant Reader", and it was sounded explicitly by Mr. J. C. Harrison in his "Retrospect and Forecast of Education for Librarianship and Professional Status". Admittedly controversial on some points, Mr. Harrison made a strong plea for well-educated and trained librarians if the public library is to be an effective instrument of education, and he claimed that at present it offered neither the status nor the remuneration which could attract or hold a sufficient number of those possessing the ability and knowledge required.

Dr. T. A. Margerison took up more specifically Dr. Bronowski's point in discussing the interpretation of science in an address to the reference and special libraries section on September 19. Dr. Margerison asserted that the average layman's ignorance of science was a danger to democracy, and stressed the need for more effective science teaching in the schools, for more writing for the layman by scientists of repute, and for more effective advice to librarians on the choice of scientific books. Mr. B. S. Page in reviewing university library development was concerned with a particular aspect, but his paper is of special interest to the scientist as such. Recalling the assertion of the University Grants Committee in its report of 1921 that an adequate library is not only the basis of all teaching and study but also an essential condition of research, Mr. Page discussed the implications for the university library of the post-war expansion of the universities. The two-fold function of the university library, of supporting both the teaching of the undergraduates and the creative work in scholarship or science of the postgraduate students and the university staff, was not at all easy to balance. Mr. Page emphasized the importance of the library representing to all, and not least to undergraduates, the unity and not the fragmentation of knowledge. The whole question of training the student in the use of the library required more study, and Mr. Page referred to the investigation into the adequacy of present library techniques to the needs of scholarship initiated by the Ford Foundation, and to the pilot survey which the Nuffield Foundation was conducting at Leeds in the use of books in a university library. Stressing the importance of the initiative of the library in connexion with general education, Mr. Page suggested that the university library should include a centre of disinterested reading, looking and listening, and that the right kind of help and the right atmosphere were what the student needed. On the expenditure side, Mr. Page said little. He pointed out that according to the University Grants Committee's returns for 1955–56, fifteen universities and university colleges spent on books and bindings a total of £214,586, or about the amount spent by Harvard University alone, the total for England, including Oxford and Cambridge, being £487,786, but he did not attempt to analyse expenditure or holdings in relation to expansion.

Of the remaining papers, Dr. C. W. J. Higson's review of the libraries of the university institutes of education should be mentioned.

STRIVING FOR RIGOUR IN GREEK SCIENCE

IN an address delivered at Dublin to Section A (Mathematics) of the British Association, entitled "The Striving for Rigour in Greek Science", Prof. C. Lanczos compared the standards of mathematical rigour set by the Greeks with the standards of to-day, and examined their claims to be regarded as complete in terms of the general Greek philosophical back-

ground. In particular, it is to be remembered that to the Greeks geometry was not a professional or technical craft, but "a divine service, pursued by the select minds who could face the shadowy world of abstract ideas".

The pattern of Greek geometry has a three-fold basis: definitions, axioms, postulates. Definitions are intended to tell us what we are talking about; axioms give the fundamental and general basis of philosophical language; postulates, which ask for certain propositions to be granted, are assumptions special to geometry. The distinction between axioms and postulates was clear to the Greeks, who properly based the theory of parallels on a postulate rather than on an axiom, but later workers confused the issue: Prof. Lanczos considers that Kant's philosophy is partly defective because he placed axioms and postulates on the same footing. The present view of mathematics as a language and of deduction as a game with symbols again implies a three-fold basis of undefined elements, definitions and rules. The difference, according to Lanczos, is chiefly one of emphasis; to the Greeks, mathematics was an abstract language describing real things, to us mathematics is a language which need not have a physical meaning. Only if a correspondence can be set up between mathematical words and physical objects does a physical meaning emerge.

In dealing with limits, Prof. Lanczos notes that in the theory of irrationals due to the great Eudoxus, the method of exhaustion uses sequences of inequalities and avoids infinitesimals and equations involving infinitesimals. The dangers of the concepts of Newton and Leibniz, so caustically exposed by Berkeley, do not arise. The Greek method, when allowance is made for the difference between their geometrical language and our algebraic language, is precisely that recovered in the early nineteenth century by Cauchy and Gauss, and developed during that century by Dedekind, Weierstrass and many others. The subtlety of the Greek genius is particularly well shown by the observation, attributed to Archimedes, that a hitherto undetected postulate is required in the method of exhaustion, namely, that if ε is any positive number, an integer n can be found such that $n\varepsilon > 1$. It is, of course, now a commonplace that geometries can be constructed in which the Euclidean postulates hold, but in which the Archimedean postulate is not fulfilled.

Prof. Lanczos's conclusion is that contemporary mathematics adds nothing essentially new to the high standards of Greek rigour.

FOOD INVESTIGATION, 1956

THE research with which the Food Investigation Board is concerned lies between primary production on one hand and nutrition on the other; it includes, therefore, studies on the biological structure of raw foodstuffs and the changes that occur during storage, preservation, processing and cooking. The Board recognizes two types of objectives in its investigations, the first being knowledge of the physical and chemical properties of various types of foodstuffs, while the second is of short range and is concerned with the solution of specific practical problems. This dual approach is well illustrated in "Food Investigation 1956"*, which contains the reports of the Food Investigation Board and of the director of the Food Investigation Organization.

In the former the importance of close collaboration between research stations and the industries concerned with implementing the results of the research is emphasized. With this end in view, the setting up of a meat research laboratory in close association with an abattoir is strongly recommended. The Board is satisfied that a proper balance is maintained within the Organization between fundamental and applied work for the attainment of ultimate practical objectives.

The Director's report gives details of work performed during the year in the various stations of the Organization; on fish and fish products at the Torry Research Station and Humber laboratory, on fruit, vegetables and plant products at the Ditton and Covent Garden laboratories, and at the Low Temperature Research Station in Cambridge on meat and meat products, eggs and poultry, as well as biochemistry and biophysics.

Work at Torry has continued on the effects of preservative ice containing chlortetracycline (aureomycin) on the keeping quality of fish. Full-scale trials were conducted on the Station's research vessel *Sir William Hardy*, and it was concluded that the presence of 5 p.p.m. of the antibiotic in the ice extended the storage life of fish in ice by seven to ten days. Food regulations in Britain at present do not permit such additions to ice, and considerable work is needed before this practice can indeed be shown to be harmless. Work has also been concerned with the cleanliness of fish boxes, which has been shown to affect the keeping quality of fish. Since cleaning and sterilizing of wooden boxes are difficult problems, trials with a non-returnable fish box of moulded resin-impregnated paper pulp have been continued. Basic investigations include studies on the proteins, lipids and extractives of fish flesh, and on the chemicals responsible for the development of brown discolorations during the dehydration of fish. The well-known sugar–amino-acid reaction is not, apparently, the only factor concerned. Other basic work has been on some of the physical factors that affect the deposition of smoke during smoke curing. The bacteriology section has continued its investigations on marine bacteria, and a type culture collection is maintained that is used by workers throughout the world.

In the Meat and Meat Products Division at the Low Temperature Research Station and the Smithfield laboratory, work has proceeded on the improvement of the quality of frozen beef and on the problem of carcass wastage, that is, the loss of weight of animals that takes place prior to slaughter. Basic work included a detailed study of normal *rigor* in animals and of the distribution of dipeptides within the muscles of various species.

A feature of the work of the General Biochemistry and Biophysics Division has been a study of the preservation of foods with ionizing radiations. This work, begun on a small scale in 1949, was resumed in 1955 and is now particularly directed to the treatment of meat. One of the main problems is that a dose of radiation sufficient to sterilize a foodstuff

* Department of Scientific and Industrial Research. Food Investigation 1956. Report of the Food Investigation Board with the Report of the Director of the Food Investigation Organization. Pp. 68. (London: H.M. Stationery Office, 1957.) 3s. 6d. net.

usually produces an unpleasant odour and flavour. Consequently radiation 'pasteurization', in which considerably lower dosages are required, seems to show more promise; the product, although not sterile, has an enhanced storage life at low temperatures.

Studies in the Fruit, Vegetables and Plant Products Division include work on nitrogen metabolism in fruit trees, on the organic acids in apples, strawberries and cherries, and on the respiration of apple tissue slices. Of a more immediately practical nature has been the work on the storage and transport of fruits and vegetables. Considerable success has been achieved with the transport of precooled strawberries in insulated containers with solid carbon dioxide suspended at roof-level, and in the use of nonyl alcohol as a sprout suppressant for potatoes. The Covent Garden laboratory has now increased its collection of coloured slides of disorders and diseases of fruits and vegetables to more than three hundred and fifty.

The volume concludes with details of the Food Investigation staff and a list of the ninety-four publications by members of the staff during the year. There is a complete index, and the report can be thoroughly recommended as a compact record of the results obtained and as a guide to the directions in which work is progressing in food research in Britain to-day.

P. L. PELLETT

THE MELLON INSTITUTE

REPORT FOR 1956

THE annual report of the chairman, M. B. Ridgway, to the Board of Trustees of the Mellon Institute for the year ended February 28, 1957, in which the Institute expended 5,187,353 dollars on fundamental and applied research, is entitled "Advantages from Research in Mellon Institute"*. Before describing the activities of the various research departments and fellowships, the report outlines the respective advantages of basic and applied research, following the Trustees' decision this year to cultivate extensive fundamental research, particularly on major problems of far-reaching importance to chemistry and allied sciences. Fifty-five members were employed in the six research departments, and 507 fellows and assistants were working in the forty-five multiple and twenty-four individual fellowships in operation during the year, while the servicing staff numbered 214. Of these fellowships, eight had been in operation for thirty-five years or more, six for twenty-five years, twelve for twenty, nine for fifteen and three for ten years.

In the Department of Research in Chemical Physics a new mounting device for carbon replicas, developed for orienting surface structures visible under the light microscope so that electron micrographs may be obtained, has been used for studying the complicated structure of cleavage surfaces in the amethyst. A reference intensity scale for visual comparison of the line intensity on a photographic emulsion has been developed for semi-quantitative spectrochemical analysis. Spectral evidence was obtained of tautomerism in diazo ketones and an X-ray diffraction method was developed for determining total crystallinity in elastomers which undergo preferential molecular orientation before crystallization.

In the Department of Research in Physical Chemistry the use of nuclear magnetic resonance spectra of adsorbed particles on silica and other absorbents is being investigated. Various organic liquids were separated by thermal diffusion and in the study of packed columns cellulose was substituted for glass-wool packing and further studies were made in the design and operation of a thermal diffusion column with a top reservoir. Work on the determination of branching in diene polymers was started.

In the Department of Instrumentation work continued on the evaluation and development of analytical balances and a new technique has been devised which involves modified arresting, mechanical handling of the weighed object and a new case design so that the whole operation can be performed automatically while a printed record is obtained. Rapid weighing at high temperatures is also being explored, while the Department of Applied Mathematics has worked at a series solution for large deflexions in simply supported disks under uniform loading. An investigation of combustion methods at high temperatures for the macrodetermination of carbon, hydrogen, sulphur and halogens in organic or metallo-organic compounds was initiated in the Department of Analytical Chemistry, where a procedure was devised for microdetermination of small amounts of residual carbon on inorganic catalysts, and the fundamental study of *Ferrobacillus ferroxidans*, the chemosynthetic autotrophic bacterium isolated from bituminous coal mines, was continued. The Department of Radiation Research, created in September 1956, is seeking to apply the radio-iodine scavenger technique to determine the nature of the free radicals produced in the radiolysis of organic materials.

Among the programmes of the Institute's continued fellowships may be mentioned a completed two-year investigation of the pulmonary effects of synthetic silicate materials, and investigations of the relation between the products of laboratory fermentations of vegetable matter and organic substances found in natural streams, using the carbon-filter technique, which indicate that the phenolic material consists of highly substituted single phenyl rings. Besides the preparation of anticarcinogenic agents related to bifunctional molecules, such as the nitromustards, and substances related to azaserine, the antimetabolites of *p*-hydroxybenzoic acid have been examined in a search for agents effective against typhoid fever, malaria and tuberculosis. Drugs effective against schistosomiasis and virus diseases have also been sought. Under the Amine Fellowship new or improved processes for the preparation and manufacture of more than fifty medicinals have been studied intensively, and improved methods have been devised for administration or pharmaceutical use of established drugs, including a granular form of aminophylline, while a 1 per cent aqueous solution of iodine, containing triethanolamine hydriodide as solubilizing agent, was found to be an efficient antiseptic and germicide with comparatively low irritant action on tissues.

The Multiple Fellowship on Power Rectifiers is placing increasing emphasis on the preparation and purification of silicon with a view of developing an

* Advantages from Research in Mellon Institute, 1956–1957. Pp. vi+54. (Annual Report Series, No. 44.) (Pittsburgh, Pa.: Mellon Institute, 1957.)

efficient silicon rectifier, and has initiated a study on the formation of rectifying junctions in silicon by solid state diffusion and by alloying processes. Under the Computer Components Multiple Fellowship investigations were directed to a fundamental understanding of the parameters influencing the brightness characteristics of electro-luminescent phosphor screens. In addition to studies of the friction and lubrication of fine instruments, under the Watch Technology Fellowship properties such as thermal stability, low friction and wear, dimensional stability and good electrical properties over a wide temperature range are being sought in polymeric substances.

Other fellowships were concerned with heat losses through joints on high-temperature piping, due to expansion of the pipe and shrinkage of the covering, the high temperature viscosity of clays and the deleterious effect of balling in mixes used for dry-pressing refractories. Certain organic amines of high molecular weight reduced or eliminated balling of the clay by lowering its hydrophilic nature and plasticity, as little as 0·2 per cent on a small-scale plant trial reducing balling in a commercial mix by 50 per cent. The curious accelerative effects observed in an examination of the relaxative behaviour of silicon nuclear spins in silica-glass have been traced to a reaction between the silicon-spin system and the spins of hydrogen atoms present in silica through its contamination with some form of water, while considerable progress was made in determining the part which traces of contaminants play in sensitizing crystalline and glassy silica to the action of high-energy radiation. In attempts to develop an improved method for evaluating the mechanical strength of glass, evidence was obtained that the sodium–vapour technique may be a useful tool for detecting the existence of flaws invisible under ordinary optical examination. A basic study has been made of the nature of alkali attack on porcelain enamels, together with differential thermal analysis studies on such enamels and related ceramic chemicals. Deoxidation practices in basic welding processes and the way these effects may be used for influencing porosity and physical properties of metal deposited in arc-welding have also been investigated, as well as problems in building supersonic wind tunnels and the erection of the vessels for the full-scale nuclear-energy plant.

In a three-year-old evaluation of synthetic resin coatings on blast-cleaned and steam-cleaned surfaces, the systems alkyds, phenolics, vinyls and chlorinated rubbers have already exceeded the performance of conventional paints used as controls, and a new series of modified epoxide resins, the 'Capsulon' resins, complementary to the 'Stypols' in properties, is expected to find wide use in the electrical industry as impregnating, potting and casting materials. Satisfactory paper chromatographic procedures have been worked out for determining dihydric phenols and some of their derivatives, and by combining polarographic and infra-red data with chemical results, the surface chemistry of most carbon blacks has been characterized in terms of quinone and hydroquinone groups.

The report includes a general review of the achievements during the past forty-five years of the Petroleum Multiple Fellowship, which has carried out studies of the rates of oxidation of asphaltene fractions of several amides, the synthesis and properties of porphyrin–vanadium complexes, including the preparation of 2 : 4-dimethylpyrrole and 2 : 4-dimethyl-3-ethylpyrrole, as well as devising a method of structural group analysis for oils of high sulphur content and studying the mechanism of carbonium-ion formation over acidic catalysts.

The Bone Products Multiple Fellowship has done much development work on a new granular absorbent for corn syrup refining. Use of polyoses as ingredients of prepared adhesives from cheap starches and dextrins has evoked considerable interest. Work on methyl glucoside continued to show promise, and much attention was given to the development of a preweaving size for filament acetate, using various types of 'Excello' dextrins. Data obtained from filtration tests have been correlated to assist in specifying fabric-filter media for increased efficiency, versatility and useful life, while processes have been developed for applying powdered resins to the surfaces of man-made fibres to increase their resiliency and stiffness and thus give adequate resistance to water-pressure during immersion. Efforts to improve the quality of hydraulic brake fluids have met with continuing success. The mechanism of the ester-amide exchange between methyl fatty acid esters and alkanolamides was studied and the search for heat and light stabilizers for dispersion–resin systems has been intensified. Rheological studies on silicone polymers led to a theory of association and tanglement explaining the anomalous properties of linear high polymers.

THE FORESTRY COMMISSION

REPORT FOR 1955–56

THE first planting work carried out by the Forestry Commission after its inception in 1919 was undertaken at Eggesford Forest between Exeter and Barnstaple. In May 1956 the Queen, with the Duke of Edinburgh, visited Eggesford to unveil a commemorative stone recording the planting by the Commission of the millionth acre of forest in Great Britain. A new policy with respect to planting was published in a White Paper in 1943, but it did not come into force until 1947 and proved rather too ambitious in its proposals for the acquisition of land, and planting consequently suffered.

In the new programme, an area of 900,000 acres of planting in the first ten years was prescribed. A total of 548,000 acres has in fact been planted, or 61 per cent of that proposed. For acquisition an area of 850,000 acres was proposed; actually, only 493,000 acres were acquired. The planted area excludes that acquired as the Commission has on hand a considerable area of plantable land and considerable stocks of plants available. The acquisition of land is now the main problem. For years now 5,000,000 acres of forest has been considered the proper proportion for Great Britain, and the Commission still holds to this view*; but it need not be all Government forest if private owners play their part and maintain a correct forest management.

There is little doubt that there is adequate land of relatively low agricultural value and of the right planting type. The question is whether, at present, the acquisition of land is not regarded too much from the point of view of production of marketable

* Forestry Commission. Thirty-seventh Annual Report of the Forestry Commissioners for the year ended 30th September, 1956. Pp. 94+4 plates. (London: H.M. Stationery Office, 1957.) 4s. 6d. net.

timber to the exclusion of land which, though not unsuitable for the growth of trees, would produce timber of poor quality and slow growth. Such trees would nevertheless give valuable protection to neighbouring and more valuable land. Land acquisition is the problem, and the Commission is quite correctly unwilling to use compulsion; nor would such action further the purpose in view. Rather, the co-operation of owners and occupiers of hill land is sought.

Private planting has been more encouraging, and for the year 1956 for the first time the area planted privately, namely, 27,100 acres, exceeded the programme of 25,000 acres proposed in the White Paper. For the first decade of the period covered by the policy outlined in the White Paper, private owners planted 165,000 acres, as against the 200,000 acres proposed in the programme. In the past three years private planting has steadily increased. The grants under the dedication scheme have been increased owing to the general increase in costs; the planting grant has been raised from £15 to £17 per acre and the maintenance grant from 5*s*. to 5*s*. 6*d*. per acre. The thinning grant remains at £3 15*s*. per acre.

Special planting operations have been in force in crofting districts in the Highlands, where close liaison is maintained with the Department of Agriculture for Scotland and the Crofter Commission. From a report of a survey of mid-Wales, the trend toward a declining and ageing population is to be traced in a region of naturally low agricultural potential, and any development for improving agricultural conditions would result in the employment of still fewer people on the land. Many acres would degrade or fall out of production and should be available for planting by the Commission.

The markets for the thinnings, even small material, are becoming more favourable, and this should be an incentive to private planting. The protection of the forests from fire is still a matter of the gravest concern.

'ANGELS' ON CENTIMETRIC RADARS CAUSED BY BIRDS

By W. G. HARFER

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SINCE the inception of high-power centimetric radar, unexplained echoes have been observed which for want of a valid explanation have been termed 'angels'. They appear as small blobs on a plan-position display, are usually indistinguishable from echoes received from point targets, and occasionally occur in immense numbers. As output powers have increased, in pace with the requirements of aviation, the range of detection of these displays has also increased (reports have been received of widespread displays out to 80 miles), and they have come to present a hazard to airfield-control and military-type radars.

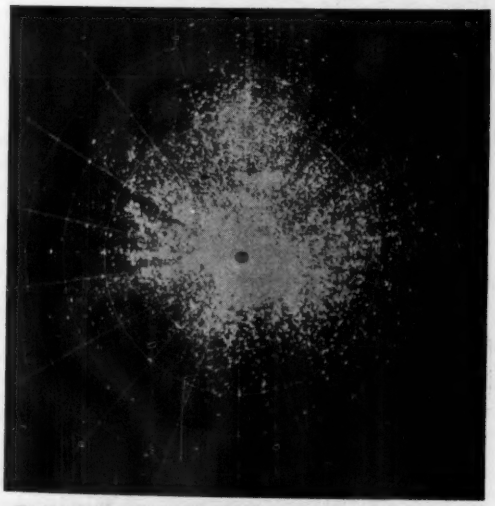

Fig. 1. Widespread display of 'angels' on 10-cm. plan-position display. Many appear as strong as echoes from aircraft. Range markers at 5-mile intervals

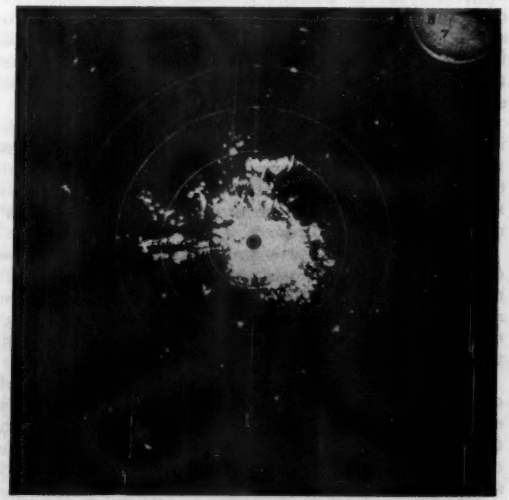

Fig. 2. Permanent echoes caused by rising ground, trees, buildings, etc., on the same scale for comparison. No 'angels' are present. The few stronger pip-echoes beyond 10 miles are from aircraft

As these effects have not been given wide publicity, examples are shown (Figs. 1 and 2) of photographic records made at East Hill, which is in open country close to the Chiltern Hills, 30 miles north-west of London. The equipment used was a 10-cm. plan-position display, peak power 500 kW., pulse-length 2 μsec., beam-width in azimuth 1½° to half power.

Lack and Varley[1] as early as 1945 reported that some point target radar echoes were caused by large sea birds, but it has generally been held that birds could not cause displays apparently spread uniformly over large areas. Insects have been considered[2], but

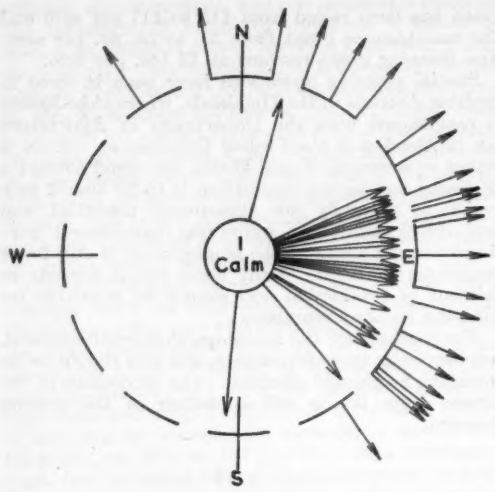

Fig. 3. Spring 'angel' movements (February–April) in inner zone. All available East Hill records (24 days in period 1952–57). Wind directions in outer zone

the widely accepted view is that radar 'angels' are primarily of meteorological origin[2,3]. Various theories have been developed invoking either reflexion at an interface, or refraction by meteorological elements containing steep gradients of refractive index, but no single theory has managed to explain more than a few of the observed properties of 'angels', and the theoretical requirements have in each case been so stringent as to be difficult of acceptance.

In searching for another approach to the problem, it was realized that the most intense occurrences were at the times of spring and autumn bird migration, and we have now found substantial evidence that even the densest of these displays of 'angels' may be caused by birds.

Interesting evidence is provided by the directions of movement of 'angels'. All available East Hill records of these in the months February–April are shown in the inner zone of Fig. 3 (we have many more recorded occurrences of 'angels', but in most there is no clue to the direction of movement).

Where the directions on any one day had a spread of values, for example, 060–085°, a single vector is entered against the mean value. All but two lie in the sector 060–140°. The wind directions at the levels of occurrence (derived from the nearest radar-wind soundings) are shown in the outer zone. They are prevailing west to south-west winds, in general agreement with the 'angel' movements, but are spread through almost twice as big an azimuth sector. It might be thought that the 'angels' only appear not to move with the wind because the radar-winds are unrepresentative, but we have examined the individual pairs of directions and find that many of the 'angel' movements have an undeniable and substantial crosswind component. The two inconsistent movements of Fig. 3 are examples of this: (1) The movement towards 185° occurred with a strong north-west wind on February 1, 1952. It suggests a 'weather movement' of wintering birds[4]; (2) that towards 015° occurred with a strong south-east wind which must have caused heavy lateral drift. Vector addition shows that birds drifted by this wind must in fact have been heading east-north-east, a normal direction of migration.

The autumn 'angel' movements (Fig. 4) are equally interesting. They are seen to be divided between south and west in a 160° sector, but the winds are strikingly variable. There are six days with winds between west and north-west, but not one case of 'angels' moving with these winds. It seems irrefutable that 'angels' of this type are not wind-borne.

These movements are quite inexplicable in terms of any proposed meteorological theory of 'angels', but are quite consistent with bird migration movements. Easterly movements in spring (Fig. 3) would be mainly departures of flocks of wintering birds to their breeding grounds in north-central Europe, followed by passage migration through southern England, while the concentration of southerly movements (Fig. 4), which are spread evenly throughout the four months, suggest birds bound for the Continent; the west-north-west movements, birds from northern Europe which winter in Ireland. Such movements in southern England have been extensively reported (for example, Lack[5]). Heavy October westerly movements of chaffinches (*Fringilla coelebs*), skylarks (*Alauda arvensis*) and starlings (*Sturnus vulgaris*) have been reported at Oxford, only 35 miles west-south-west of East Hill[6]. Five out of the six west-north-west 'angel' movements of Fig. 4 actually occurred in October, one in November, and we conclude that the west and west-north-west 'angel' movements are these same regular migration movements towards Ireland.

A noticeable feature is that 'angels' commonly move faster than the wind at their height, with speeds sometimes twice the wind or even more. We have made ninety-two measurements from radar of the ground-speeds of individual 'angels', spread over nine days in the period of spring migration, and have subtracted probable winds vectorially. The overall range of airspeeds derived, 22–56 m.p.h. (maximum concentration 33 m.p.h.), is in good agreement with recorded still-air flight speeds of common birds[7].

This evidence is admittedly inferential, but we have some direct evidence. When using a target-

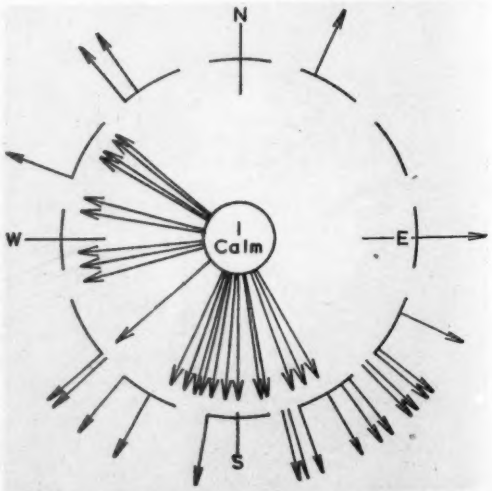

Fig. 4. Autumn 'angel' movements (September–December) in inner zone. All available East Hill records (22 days in period 1952–56). Wind directions in outer zone

tracking radar to track 'angels', on occasion of a widespread display, small flocks of birds have been detected in the field of a telescope fixed to the moving aerial. It was clear that the radar was following their flight, often through considerable changes in azimuth and elevation, and that each individual 'angel' was in this case the composite echo from one flock of 5–30 small birds.

It is hoped to publish more details of this work elsewhere, and to show that other aspects of the occurrence of 'angels', such as their seasonal distribution, and spread in altitude, also point to the conclusion that all widespread displays of 'angels' on centimetric radars in southern England are caused by birds. We can see no reason to invoke any other mechanism to explain them.

The permission of the Director-General of the Meteorological Office to publish this communication is gratefully acknowledged.

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MOVING VISUAL IMAGES PRODUCED BY REGULAR STATIONARY PATTERNS

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REGULAR patterns have a peculiar status from the point of view of information theory as being rich in 'redundant' information. Redundancy, despite the pejorative flavour of the word, is not always an undesirable property. In particular, it enables an information system in principle to transmit a message in the face of disturbances or 'noise' which would destroy a less-redundant transmission. To profit from redundancy in this respect, one must in effect reduce the number of degrees of freedom of the signalling system, thus increasing the informational efficiency, by 'recoding'.

These considerations suggest that in investigations of the visual information-system it might be specially interesting to observe the effects of highly redundant information patterns, since the nervous system might conceivably have its own ways of profiting from such redundancy.

As a first step in this direction, some simple stimulus figures have been constructed which fill an appreciable area of the visual field with highly redundant information. Some of these (for example, patterns of parallel lines) are already well known for their disturbing visual effects[1,2], particularly those due to eye-movements.

The main purpose of this communication, however, is to give a preliminary account of some particularly striking after-effects of such regular patterned stimulation, which seem to offer a promising new line of research into visual organization. One of the most interesting patterns so far constructed consists of 120 black radial stripes of width 1½ degrees (Fig. 1), on sheets of matt white photographic paper, 30 cm. × 40 cm., viewed at 1 metre in daylight or normal room lighting. (Neither distance nor illumination is critical.) After an exposure of, say, 10 sec. this 'ray' pattern produces for a few seconds an immediate after-impression of wavy lines moving in circular orbits at right angles to the stimulus lines. It is proposed to call this the 'complementary pattern'. For most observers its initial direction of rotation appears to be constant. Out of a series of 110 subjects, 83 reported it as clockwise, 27 anti-clockwise. A few in each group saw the direction reverse spontaneously. 7 out of 83 of the 'clockwise' group and 5 out of 27 of the 'anti-clockwise' group were left-handed. There is thus no simple correlation with handedness, though the evidence suggests that left–right dominance may be one relevant factor. The direction may be induced to reverse by fixating a point to left or right of the centre of the stimulus pattern.

If part of the stimulus pattern is covered (for example, by a sheet of paper obscuring one half) during inspection, the corresponding portion of the complementary pattern is missing, but the portion which is visible is unchanged.

A second pattern made up of concentric black circles on a white background (Fig. 2) was designed as a dual of the 'ray' pattern. As might be expected, this 'target' pattern gives a complementary pattern dual to the first, rather like the petals of a chrysanthemum. Wavy lines stream radially from or to the centre, but the image does not normally appear to rotate. Here again it has been found unnecessary that the stimulus pattern should be complete, a

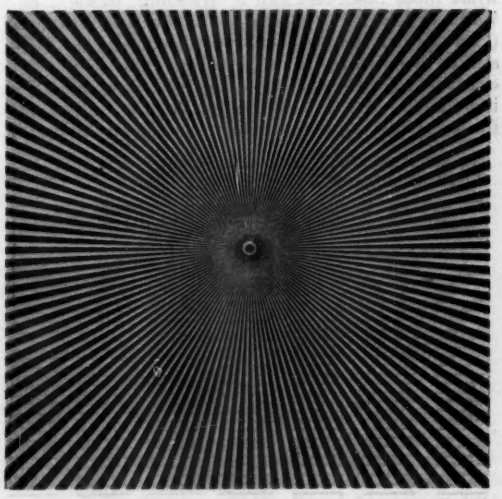

Fig. 1

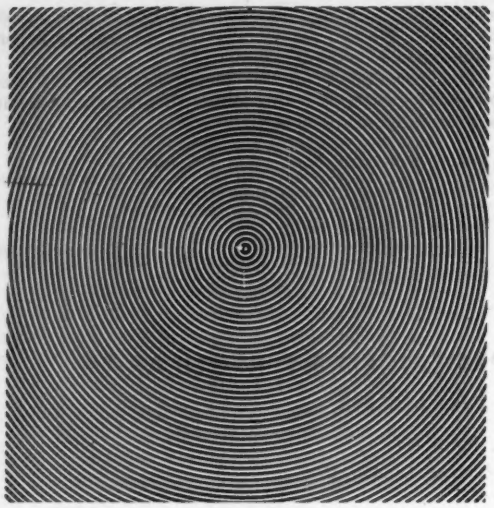

Fig. 2

portion of the stimulus figure giving rise to a corresponding portion of the 'chrysanthemum' image.

These effects are more striking after binocular than after monocular stimulation. During prolonged monocular stimulation the complementary image may often be seen in apparent rivalry with the stimulus pattern, subjectively rather as if it were being presented to the occluded eye on a black background. This suggests that the activity it represents is not an 'off-response' but some kind of co-operative oscillation induced in the visual network by the regularity of the stimulus. This view is strengthened by four further facts: (*a*) Small blank areas introduced into such stimulus patterns appear under suitable conditions to be traversed continually by rapidly moving shadows. The phenomenon is well seen in patterns of parallel black bars arranged in columns side by side (Fig. 3), where the vertical channels between the columns of bars appear to show what most observers call a 'trickling' motion, as if water were running rapidly up or down each channel. (It was a chance observation of this on slotted B.B.C. studio wall-board in 1955 which first led me to experiment with patterns of parallel lines, and I am indebted to Mr. C. L. S. Gilford, of the Corporation, for assistance in making measurements on the original material.) The effect is more marked if the bars have square-cut ends than if they are rounded off. The complementary after-image of a parallel-bar pattern of this kind consists of wavy lines moving perpendicular to the bars, that is, in the direction of the channels between the columns of bars. It seems most likely, therefore, that the same activity is responsible for the 'trickling' seen during exposure of the pattern. (*b*) A randomly printed pattern of dots, viewed through a transparency of Figs. 1 or 2, takes on a static structure similar to that of the complementary image. Relative motion of the two patterns causes an interesting 'shearing' of this structure which is being investigated. (*c*) A spatio-temporally random pattern of visual 'noise' on a cathode-ray tube screen, viewed through such transparencies, evokes a vivid and continuous impression of the complementary image in motion. This discovery offers a simple technique for the future study of these images. (*d*) In stroboscopic light at rates of a few flashes per second, somewhat simplified complementary patterns of the same family may be observed superimposed on the stimulus pattern, usually outlined in a blue or green colour of remarkably high saturation.

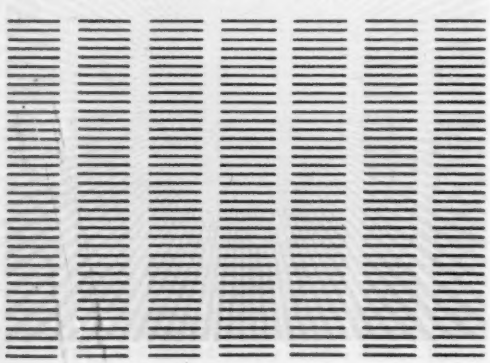

Fig. 3

The theoretical implications of these results are as yet far from clear, but it is suggested that there may be a significant connexion between the new phenomena and the well-known static figural distortions produced by similar patterns. In both cases, the universal rule is that the system tends to favour the direction at right angles to the regular contours, suggesting a theoretical model of form-perception in which directions at right angles are treated by the system as competitive. These phenomena could then be considered as evidence of what might be called 'directional satiation' in the appropriate network, together with co-operative oscillation (a kind of generalized standing-wave pattern) in response to the informational redundancy.

It will obviously be of great interest to localize these complementary responses. The evidence from monocular stimulation mentioned above suggests (though far from conclusively) that they are less likely to be of retinal than of central origin. On the other hand, it has been found that if Fig. 2 is presented to a subject satiated for rotation by viewing a turntable, the well-known rotational after-effect is superimposed on the 'chrysanthemum' after-image, which now appears to rotate in the opposite direction to the turntable. In preliminary experiments with a subject suffering from damage to the brain (to be reported elsewhere) a lesion due to a cerebral embolism, resulting in a wedge-defect in one quadrant, was found to suppress the complementary after-image of Fig. 1 over the whole of the damaged half-field, whereas that of Fig. 2 (the 'chrysanthemum') was suppressed only in the area of the scotoma, which became observable to the subject as a blank patch on the complementary image. After rotation satiation, the 'chrysanthemum' was reported to rotate past the blank patch. It seems, then, that the source of the oscillatory after-images lies on the retinal side of whatever system is modified by viewing the turntable. It is hoped that further experiments with subjects with brain damage may help with the problem of localization.

The assistance of Mr. W. R. Pritchard in constructing Figs. 1 and 2 is gratefully acknowledged.

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PROTOPLASTS OF *E. COLI* AS SOURCES AND ACCEPTORS OF DEOXYPENTOSE NUCLEIC ACID : REHABILITATION OF A DEFICIENT MUTANT

By Prof. ERWIN CHARGAFF, HERBERT M. SCHULMAN and Dr. HERMAN S. SHAPIRO

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THE complete isolation of intact deoxypentose nucleic acid from *Escherichia coli* is not easy ; and although deoxypentose nucleic acid preparations from this micro-organism have been described[1–3], and in a few cases fully analysed[1,2], it is not impossible that the unsatisfactory quality of many of these specimens is one of the reasons for the scarcity of information on bacterial transformation in this genus[4–6]. It seemed to us that experimentation would be facilitated if the organisms—donors as well as recipients of the biologically active material—were deprived of their cell walls. In the past few years great advances have been made in our understanding of protoplasts, forms of organized and, in some circumstances, viable bacterial protoplasm, remaining after the removal of the wall[7].

We have, consequently, explored the use of protoplasts of *E. coli*[8–10]. In the experiments reported here the penicillin method of Lederberg[8] was employed. The strains used, for which we are grateful to Prof. B. D. Davis, of New York University, were the wild-type *E. coli* strain *W* and the lysine-requiring mutant 26–26 derived from it. The latter is regarded as being blocked between α,ε-diaminopimelic acid and lysine[11].

We shall first describe the isolation and the composition of deoxypentose nucleic acid prepared from the protoplasts of the wild-type strain and then present the evidence of the restoration, by this deoxypentose nucleic acid, of the protoplasts of the lysine auxotroph to prototrophic conditions no longer requiring a supply of lysine—a form of bacterial transformation to which we should like to refer as 'redintegration'.

Crude nucleic acid from E. coli *protoplasts.* For each preparation, 300 ml. of a culture of *E. coli* strain *W*—grown overnight at 37° in 'Difco Penassay' broth—was added to 1,000 ml. of the same medium containing 20 per cent sucrose, 0·2 per cent magnesium sulphate and 1,000 units per ml. of penicillin[8]. After three hours on a rotating shaker at room temperature, only protoplasts could be seen. These were collected in the cold by centrifugation at 5,000*g* for 20 min. and washed twice with 80 ml. and 40 ml. of 20 per cent sucrose solution. The washed protoplasts first were extracted twice with 30 ml. portions of cold 0·1 *M* sodium chloride solution (0·05 *M* with respect to sodium citrate), each treatment being followed by centrifugation in the cold at 23,000*g* for 20 min., and the sediment then was rapidly stirred for 15 min. with 25 ml. of cold 10 per cent sodium chloride solution. The viscous suspension was centrifuged (23,000*g*, 20 min.) and the sediment extracted once more for several hours. The slightly opalescent supernatant fluids were injected into 2 volumes of 95 per cent ethanol. The fibrous precipitate was collected and the cycles of extraction with 10 per cent sodium chloride solution, centrifugation and precipitation with alcohol were repeated. Most of the fibres could be dissolved in 10 ml. of 0·15 *M* sodium chloride solution. The solution was clarified (23,000*g*, 40 min.) and adjusted to a molarity of 2·6 by the addition of solid sodium chloride ; the crude nucleic acid was precipitated with 2 volumes of ethanol and stored in the cold in 70 per cent ethanol.

This is the stage at which the preparations were used in the subsequent biological experiments. They were isolated with the avoidance of any but the mildest procedures for the removal of protein and ribonucleic acid that are successful in the preparation of deoxypentose nucleic acid from calf thymus[12] ; but they were not pure and contained varying amounts of ribonucleic acid and protein. For example, 300 ml. of initial bacterial culture yielded, in one case, 6·3 mgm. deoxypentose nucleic acid, 2·6 mgm. ribonucleic acid, 2·2 mgm. protein ; in another preparation, the figures were : 4·1 mgm. deoxypentose nucleic acid, 2·4 mgm. ribonucleic acid, 2·2 mgm. protein.

Composition of deoxypentose nucleic acid from E. coli *protoplasts.* It appeared of interest to determine the purine and pyrimidine composition of the protoplast deoxypentose nucleic acid. The methods of purification are mentioned in Table 1, which gives the average analytical figures for four preparations. The analyses were performed by the usual methods[13]. One of the specimens (Prep. 2) that had not been in contact with alkali had $\varepsilon(P) = 6{,}900$ at 260 mμ and *p*H 7[14]. In their composition, the deoxypentose nucleic acid preparations under study here are remarkably similar to those from other *E. coli* strains described previously[1,3,14], also as regards the unusual, nearly equimolar distribution of the nitrogenous constituents. This is the fifth strain of *E. coli* for which this holds true.

The 'redintegration' phenomenon. One series of experiments is described here, the results of which are shown in Table 2. (1) The lysine-requiring mutant 26–26 of *E. coli* was grown overnight in 'Penassay' broth at 37°. For the production of protoplasts, 3-ml. portions of this culture were added to 10 ml. of the penicillin-sucrose medium[8] mentioned at the beginning of this communication, with the following additions. Exp. 1, none ; Exp. 2, 1 per cent human serum albumin ; Exp. 3, a preparation of the crude nucleic acid from wild-type *E. coli*, strain *W* described before, in an amount corresponding to approximately 0·25 mgm. of nucleic acid phosphorus ; Exp. 4, the same quantity of the nucleic acid and 1 per cent albumin. After agitation at room temperature for 2½ hr., the protoplasts were collected by centrifugation in the cold and washed once with 20 ml. of cold 20 per cent sucrose solution which, in Exps. 2 and 4, was supplemented with 1 per cent albumin.

(2) Each protoplast preparation was suspended in 10 ml. of 20 per cent sucrose solution containing the minimal medium (7 gm. dipotassium hydrogen phosphate, 3 gm. potassium dihydrogen phosphate, 0·5 gm. sodium citrate, 1 gm. ammonium sulphate, 0·1 gm. magnesium sulphate, 5 gm. glucose per litre). Nucleic acid also was present in Exps. 3 and 4, and albumin in Exps. 2 and 4, in the concentrations mentioned above. The suspensions were shaken at 35° for 30 min.

(3) Each mixture was then added to 10 ml. of double-strength 'Penassay' in 20 per cent sucrose solution, again supplemented with the same quantities of nucleic acid (Exp. 3), albumin (Exp. 2) or both (Exp. 4). The mixtures were incubated with shaking at 35° for 2 hr., by which time the spherical protoplasts had reverted to rods, and then left shaking at room temperature for 14 hr.

(4) 10-ml. portions of each culture were centrifuged, the cell sediments were washed three times with 5 ml. portions of 0·15 *M* sodium chloride solution and finally suspended in 2 ml. of physiological saline. Proper dilutions then were spread on agar plates containing the minimal medium without or with L-lysine (50 μgm. per ml.). The results are summarized in Table 2.

When cultures, in 'Penassay' broth, of the mutant 26–26 that had not passed through the protoplast phase or been treated otherwise were harvested and dilutions of the washed cells were spread on agar plates, the number of prototrophs was 0·01 per 1,000 cells. It is not impossible that the passage through the protoplast stage in itself somewhat enhances the frequency of reverse mutation; but this remains to be developed in detail. It will be gathered from Table 2 that the treatment of the lysine-requiring protoplasts with nucleic acid from the wild-type strain produced an approximately twenty-fold increase in prototrophic cells in the presence of serum albumin (Exps. 2 and 4), a five-fold increase in its absence (Exps. 1 and 3). The protective effect of serum albumin on protoplasts of *E. coli* has been pointed out before[9].

The events controlling this restoration are far from clear. We have thus far studied the action of ten preparations of crude nucleic acid on the protoplasts of mutant 26–26 in twelve separate experiments, of which only six have given positive results. Most of the failures were, however, recorded before the use of serum albumin. We believe the principal cause of these failures to be the excessive breakage of protoplasts and the release of deoxyribonuclease; in successful experiments the suspension of protoplasts in solutions containing nucleic acid (stage 2 of the procedure described above) retained a high viscosity for a considerable period. It may also be advisable to ascertain the absence of enzymes capable of depolymerizing deoxypentose nucleic acid from the preparation of human serum albumin employed.

Table 1. Composition of Sodium Deoxypentose Nucleate prepared from Protoplasts of *E. coli*, strain *W*

	Preparations 1, 2*	Preparations 3, 4†
Moles per 100 gm. = atoms phosphorus		
Adenine	25·1 ± 0·4	24·4 ± 0·2
Guanine	25·7 ± 0·1	26·3 ± 0·5
Cytosine	25·9 ± 0·3	25·5 ± 0·5
Thymine	23·4 ± 0·3	23·8 ± 0·2
Molar ratios		
Adenine/thymine	1·07	1·02
Guanine/cytosine	0·99	1·03
Purines/pyrimidines	1·03	1·03
Adenine + thymine / Guanine + cytosine	0·94	0·93

* These preparations were completely freed of ribonucleic acid by the adsorption of the latter on activated charcoal (Zamenhof and Chargaff, *Nature*, **168**, 604 (1951)). The figures represent averages of the analytical results given by both specimens. They have been adjusted to a 100 per cent recovery. The actual recovery was 93·2 per cent.

† Ribonucleic acid was removed from these preparations by treatment with 0·3 *M* sodium hydroxide (30°, 18 hr.) and subsequent dialysis. The figures are corrected averages, as explained in the preceding footnote. The actual recovery was 86·7 per cent.

Table 2. Treatment of Protoplasts of Lysine-requiring Mutant 26–26 with Nucleic Acid from Protoplasts of Wild-Type *E. coli*, strain *W**

Exp.	Addition: DNA	Addition: Albumin	No. of viable cells in original 2 ml. portion: With lysine	No. of viable cells in original 2 ml. portion: Without lysine	No. of prototrophic cells per 1,000 cells
1	−	−	$2·2 \times 10^8$	$8·0 \times 10^4$	0·03
2	−	+	$4·0 \times 10^8$	$1·3 \times 10^5$	0·03
3	+	−	$2·0 \times 10^8$	$4·1 \times 10^5$	0·2
4	+	+	$4·3 \times 10^8$	$2·4 \times 10^6$	0·6

* The procedures for the treatment of the protoplasts are described in the text. For the viability counts, portions of each dilution were spread on three plates (48 hr., 37°). The figures are averages of closely agreeing triplicate determinations.

It would seem that the phenomenon observed by us belongs to the general category of bacterial transformation. We should, however, hesitate to affirm this before more rigorous proof has been obtained that a deoxypentose nucleic acid is the agent responsible. The permanent abolition, by a substance present in the wild-type, of the metabolic defect of an auxotroph and the restoration of the deficient cell to prototrophic requirements are, perhaps, best described as 'redintegration'. It will be of interest to see whether, in the mutant studied here, this event is accompanied by the appearance of diaminopimelic acid decarboxylase[15]. We are continuing the study of several aspects of the redintegration phenomenon and hope to give a fuller account in due course.

We thank Prof. J. Lederberg, of the University of Wisconsin, for acquainting us with his procedure for the preparation of protoplasts before its publication; Prof. B. D. Davis, of New York University, for the gift of bacterial cultures; and Prof. F. J. Ryan, of Columbia University, for helpful discussions. The work was supported by research grants from the United States Public Health Service, the American Cancer Society and the National Science Foundation.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

An Attempt to cross the Domestic Rabbit (*Oryctolagus cuniculus*) and Hare (*Lepus europæus*)

PREVIOUS attempts[1] to obtain young from domestic rabbits by insemination with epididymal spermatozoa from hares (*Lepus timidus ainu* or *Lepus europæus*) have proved unsuccessful. The possibility, however, that fertilization and a limited amount of embryonic development may have occurred has not so far been investigated. Recently[2], it was found that in rabbits inseminated with epididymal spermatozoa from the eastern cottontail rabbit (*Sylvilagus floridanus*), 37 per cent of the eggs were fertilized but degeneration occurred at all stages before or at blastulation. The experiment described here was undertaken to determine whether fertilization occurred in rabbits inseminated with hare spermatozoa and, if so, at what stage development ceased.

During May and June, four male hares (Nos. 1–4) were shot locally and returned to the laboratory within one hour of death. Spermatozoa were obtained from the epididymides and suspended in Krebs's Ringer bicarbonate solution at 37° C., which induced a high degree of motility. Each female rabbit was inseminated with 1 ml. of sperm suspension. The ten adult female rabbits, *A–I*, used for this experiment were caged separately and not mated for a period of at least 30 days prior to the experiment. They were given an intravenous injection of 1 mgm. equivalent of pituitary lutealizing hormone (PLH, Armour Laboratories) to induce ovulation. Immediately afterwards, rabbits *A* and *B* were inseminated with 110 million spermatozoa (from hare No. 1), rabbits *C–H* received 160 million spermatozoa (mixed sample from hare Nos. 2 and 3) and does *I* and *J* received 692 million spermatozoa (from hare No. 4). One Fallopian tube was removed from rabbits *A* and *B* at 31 and 54 hr. after insemination. These rabbits were allowed to recover and were then autopsied at 122 and 145 hr. after insemination. The remaining eight rabbits were killed at intervals varying from 29 to 124 hr. after insemination. The technique of egg recovery has already been described[3]. The recovered eggs were examined microscopically to determine their general condition, stage of development and numbers of spermatozoa present.

The mean total number of ovulations per rabbit was 10·6 ± 0·6 (standard error of mean), range 8–15. Details of the number and condition of eggs recovered are given in Table 1. In rabbits examined at, or later than, 73 hr. after insemination, forty-nine eggs (equivalent to 100 per cent of the ovulations) were recovered from the Fallopian tubes; two of these eggs were uncleaved, four showed retarded development, whereas the remaining forty-three had reached a stage of development appropriate to their age. A total of thirty-eight eggs (66·7 per cent of the ovulations) were recovered from the uteri of the rabbits killed at 122–145 hr. after insemination. Although all thirty-eight eggs had undergone cleavage, no egg had developed beyond the early blastocyst stage, which is normally observed 84 hr. after mating;

Table 1. EGG DEVELOPMENT FOLLOWING INSEMINATION OF RABBITS WITH EPIDIDYMAL SPERM OF HARES

Rabbit	Interval between insemination and egg recovery (hr.)	No. of ovulations	No. of eggs recovered and stage of egg development
A	31*	4	2, 1-cell; 2, 2-cell
	145	4	1 early blastocyst
B	54*	4	3, 4-cell; 1, 16-cell
	122	6	3 late morulæ; 1 early blastocyst
C	29	10	10, 4-cell
D	67	11	11 late morulæ
E	122	15	9 late morulæ; 1 early blastocyst
F	123	11	10 late morulæ
G	124	12	5 late morulæ; 2 early blastocysts
H	124	9	6 late morulæ
I	49	10	4, 8-cell; 3, 12-cell; 3, 16-cell
J	73	10	1, 16-cell; 9 late morulæ

* Tubalectomy performed

there were five early blastocysts and thirty-three late morulæ in which development had ceased between 60 and 70 hr. after insemination. Small numbers of spermatozoa, varying from one to six per egg, were observed in the perivitelline space, zona pellucida and mucin; there appeared to be no relationship between the number present and the number used for insemination. The proportion of eggs 'fertilized', as determined by cleavage, was 97·7 per cent, which is not significantly different from the figure obtained from normally mated rabbits[4].

Three questions which these observations raise are: (1) Were the eggs fertilized? (2) Did parthenogenetic development occur? (3) Why did development fail at the late morula or early blastocyst stages? The presence of hare spermatozoa in the perivitelline space and zona pellucida of rabbit eggs suggests that they provided the stimulus for development. Since no egg reached the five-day blastocyst stage, no attempt was made to determine the chromosome number[5], and it is therefore not possible to state whether male hereditary material was transmitted to the eggs. For the time being, no explanation other than incompatibility can be advanced to account for the failure of the eggs to develop beyond the early blastocyst stage. Interspecific crosses are rarely possible, and this is often thought to be due to an immunological incompatibility, of a statistical nature, between combining groups on the surfaces of the heterologous eggs and spermatozoa[6]. These observations suggest that in certain cases this incompatibility may not exist, though the other barriers to successful interspecific crosses do.

I am grateful to Lord Rothschild and Dr. T. Mann for reading the manuscript and making valuable suggestions. My thanks are due to Mr. R. V. Short, and Mr. J. Engledow of Messrs. Chivers and Sons, Ltd., for providing the hares.

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Absence of Wound Healing in Young Chick Embryos

During attempts to modify the development of feather tracts, Saunders had noted the fact that skin wounds in three-day chick embryos failed to heal[1]. This casual observation, which contrasted curiously with the numerous reports on smooth healing of embryonic transplants and the repair of older skin, seemed to hold a promising clue to the mechanisms of wound healing in general. We therefore undertook a more systematic study of the phenomenon, the first results of which are reported in the following.

Circular skin wounds were made on the dorsal side of the neck in chick embryos from five days of incubation age upward until hatching. The wounds measured in the younger embryos (5–9 days) about 0·1 mm. in diameter and 0·1 mm. in depth, and in the older ones (10–21 days) 1 mm. and 0·5 mm., respectively. After the operations, the segment of shell removed for access to the embryo was replaced by a glass window. The embryos were killed four to five days after the operation, fixed, sectioned, stained, and studied microscopically.

The normal healing of skin wounds is primarily a process of cell migration. The epidermal sheet moves with its free margin concentrically over the defect until the hole is closed by a thin layer of cells. Proliferation by mitotic division follows secondarily, gradually making up for the initial deficit of cells.

Wounds made in chick embryos older than twelve days and studied between the seventeenth and twenty-first days showed this same standard pattern of epidermal regeneration. However, embryos operated on at an early stage and studied prior to the twelfth day gave a radically different result. The epidermal sheet had not even started to move over the lesion, and its free margin was still at the site of the original wound edge. Mitotic activity near the margin was high, and the excess cell production had given rise to local thickenings and cysts. Despite this abundant growth along the border, the wound surface had remained raw, bounded only by the condensed outer layer of connective tissue cells. The earlier embryo thus is distinguished by the marked incapacity of its epidermis to spread over the wound surface, even though cell multiplication is stepped up much as in the older group that healed normally. An intermediate age-group, studied between the thirteenth and sixteenth days of incubation, showed signs of flattening of epidermal cells along the border and some contraction of the wound area, thus signalling presumably the initiation of the normal closure process. Fig. 1 summarizes the cases that survived the operation and could be properly evaluated.

It can be seen that there is a rather abrupt change in the embryonic conditions conducive to wound healing about the twelfth day of incubation. Since, moreover, embryos prior to that critical period neatly dissociate the migratory component of wound healing (which is absent) from the proliferative component (which is present), this object lends itself singularly well for a more penetrating analysis of the fundamentals of wound healing. The crucial change about the twelfth day may be found in the mobility of the epidermal cells, or in the constitution of the wound substratum, or in systemic changes in the embryo, or in the nature of the extra-embryonic fluid, or in the tensional stresses, or other as yet unsuspected

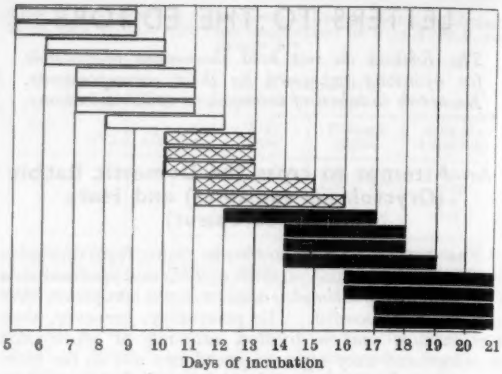

Fig. 1. Bars indicate period of observation between wounding and fixation in days after incubation. White bars, absence of wound healing; cross-hatched bars, incipient wound healing; black bars, complete wound healing

conditions. The location, shape and size of the lesion will likewise have to be taken into consideration. Experiments to pinpoint the effect are under way. One preliminary series has already led a step further in indicating that embryos operated on during the early non-reparative phase, but kept alive into advanced embryonic stages, later start to close their wounds, all just about the critical age when closure was observed in the older series. This would mean that the initiation of migration cannot possibly be related to the wound stimulus as such. It would, of course, also account for the fact that early transplants kept into later stages no longer show skin gaps, the earlier existence of which one might expect from the results reported above.

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Autoradiographic Detection of Sulphone in the Affected Tissues of Leprosy Patients

In two previous communications[1,2], the relative concentrations of diamino-diphenyl sulphone in body fluids and affected and healthy tissues of leprosy patients were compared. It was shown that the drug was preferentially concentrated in the affected tissues. In these studies the assay of radioactive drug in any tissue was made by counting macerated samples with the help of a Geiger–Müller counter.

Autoradiographic studies have now been made to determine the exact sites of localizations of the drug in the affected tissues. Positive autoradiographs of tissue sections are reproduced here.

Diamino-diphenyl sulphone labelled with sulphur-35 (supplied by the Atomic Energy Research Establishment, England) was administered to patients as a single oral dose of 4 μc./kgm. body-weight. The initial specific activity of the drug was 1·0 μc./mgm. 6–18 hr. after administration of the drug samples of tissues were obtained by biopsy. These were fixed

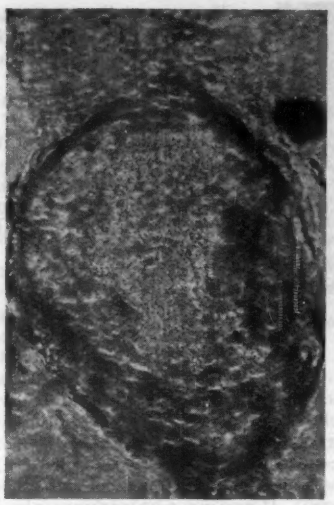

Fig. 1. Autoradiograph of the transverse section of a blood vessel. (× *c.* 1,330)

in neutral formalin and 5μ frozen sections were cut. Sections were then placed on glass slides, covered with Kodak autoradiographic stripping film and exposed for 180 days in dry light- and air-tight chambers at 4° C. Films were then developed in undiluted *D* 19*b* for 5 min. at 65° F. to keep the background as low as possible.

Fig. 1 is the autoradiograph of a transverse section of a blood vessel indicating the presence of the drug within it by the blackened photographic grains. Figs. 2 and 3 are autoradiographs of longitudinal and transverse sections of peripheral nerves. The density of the grains are more marked in places where the infiltrating cells are predominant. The space between adjacent fibrils is found to be almost free of the drug. Fig. 3 shows that the drug is more localized within the different cells of the nerve.

Fig. 2. Autoradiograph of the longitudinal section of a nerve. (× *c.* 1,330)

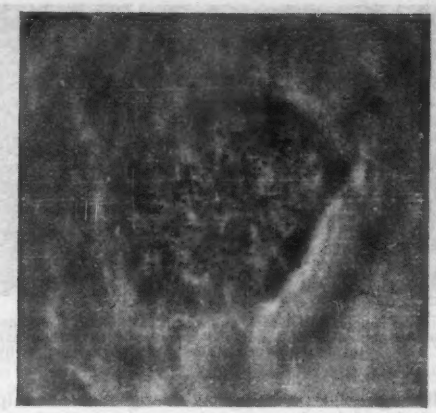

Fig. 3. Autoradiograph of the transverse section of a nerve. (× 2,000)

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Effect of Hypoglycin *A* on the Alpha Cells of the Pancreas

Hypoglycin-*A*, which is isolated from the fruit of *Blighia sapida*, causes severe hypoglycæmia and depletion of liver glycogen[1,2]. Leppla and Holt[3] examined the hypothesis that glucagon depletion following pancreatic alpha-cell damage might be the cause of these metabolic changes. However, as they could not find any microscopical changes in the alpha cells after hypoglycin *A* administration, they were unable to support this hypothesis.

In order to re-examine the possibility, the following study was carried out. Albino rats and guinea pigs were injected intraperitoneally with a single lethal dose (150–300 mgm./kgm.) of hypoglycin *A*. When death was obviously imminent the animal was killed and the pancreas was excised for histological examination. In order to check the activity of the hypoglycin *A*, blood glucose and liver glycogen levels were also determined; both of which were found to be invariably low.

Serial sections of pancreas were stained with eosin and hæmatoxylin, Gomori's chrome–alum–hæmatoxylin and phloxine[4], and Gomori's aldehyde fuchsin and phloxine[5]. A decrease of alpha granules and/or number of alpha cells in the islets was observed. Occasionally, there was a complete absence of the alpha cell (Fig. 1). The beta cells and the acinar cells appeared normal.

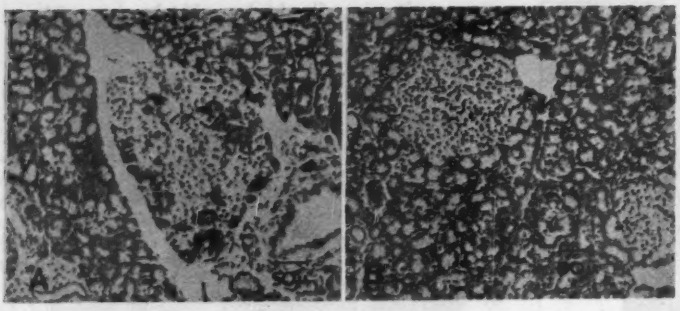

Fig. 1. Pancreatic islet of guinea pigs; Gomori's chrome–alum–hæmatoxylin and phloxin stain. *A*, Normal islet; *B*, pancreatic islets of animals which died 16 hr. after intraperitoneal injection of 200 mgm./kgm. of hypoglycin-*A*

Although the pathological changes in the alpha cells induced in these experiments by hypoglycin *A* may lead to a decrease of glucagon production, and thus contribute to the depletion of the liver glycogen and the fall of blood glucose, these histological changes are not likely to be the sole factor involved, since cobalt chloride, which produces far more extensive and destructive damage to the alpha cells, causes different metabolic changes.

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Urinary Œstrogen Excretion by the Bull

According to Leach *et al.*[1], several observations indicate that in the human male the testis accounts for 80 per cent or more of the urinary œstrogens. Maddock and Nelson[2] claim that œstrogen excretion is a more reliable and sensitive indicator of Leydig cell function than is 17-ketosteroid excretion. These views are supported by Leach *et al.*[1]. Conti *et al.*[3] found increased œstrogen excretion in six patients with hypogonadism and hyperplasia of the Leydig cells. The urinary œstrogens were doubled during chorionic gonadotropin administration. The results of Dux *et al.*[4] support the findings of Maddock and Nelson[2] that secretion of œstrogens by the mature testis is a highly specific reaction to chorionic gonadotropin. The authors claim intravenous drop infusion of chorionic gonadotropin to be of clinical value in evaluation of the endocrine functions of the testis.

In the bovine species male sterility is a problem and the need for new diagnostic methods is obvious. So far as I am aware, no attempt has as yet been made towards quantitative analysis of urinary œstrogens in the bull. In this communication results are presented which indicate that a modification of the Brown method for human urinary œstrogens[5] may be applied to determine urinary œstrogens in the bull, and that the substance isolated in the œstradiol-fraction increases significantly in response to the administration of chorionic gonadotropin.

Using specially constructed equipment, urine was collected for 24-hr. periods from a bull showing normal sexual activity.

1/10 of each 24-hr. urine was diluted to a final volume of 1,000 ml. with distilled water, and duplicates of 500 ml. each were hydrolysed for 1 hr. at 100° C., using 6 vol. per cent hydrochloric acid.

Extraction and purification were performed according to Brown[5], with some minor modifications[6]. The œstriol fraction was not analysed, as earlier experiments indicated an unspecific reaction to the Kober reagent for this fraction. The Kober reagents were made according to Bauld[7]. All readings were made in a Beckman Model *DU* spectrophotometer at the following wave-lengths: œstrone, 480, 516 and 552 mμ; œstradiol, 480, 518, 556 mμ.

The chorionic gonadotropin used was 'Physex' (Leo, Copenhagen). It was given as intramuscular injections in the first hour of the 24-hr. collecting periods on days 5, 6, 7 and 8 of the experiment. On day 8 it was given in the first and eleventh hour of the collecting period. The results are given in Table 1. No increase can be observed in the œstrone fraction during the chorionic gonadotropin administration. The amounts registered are so small as to render the determinations uncertain. However, in the œstradiol fraction a marked increase is observed. On the second day after the last injection of chorionic gonadotropin the values for this fraction fall to the initial level. The Kober chromogen in the œstradiol fraction is completely destroyed when the urine is submitted to boiling for 2 hr. using 15 vol. per cent of hydrochloric acid. Additional information from work on urinary œstrogens in pregnant and non-pregnant cows (Velle, W., unpublished work) indicate that the substances measured represent true œstrogens.

The results represent, so far as I am aware, for the first time a chemically determined increase in urinary œstrogen excretion following chorionic gonadotropin administration, and therefore give support to earlier observations in the human male, based on bioassay. They also suggest a possible new method for diagnosing certain forms of sterility in bulls.

Table 1. Increase in Urinary Œstrogen Excretion in a Bull, following Chorionic Gonadotropin Administration

Days	Treatment	Volume of urine per 24 hr. (ml.)	Corrected specific gravity of urine	μgm. per 24 hr. Mean of duplicates	
				Œstrone	Œstradiol*
1	None	6,100	1·036	4·9	14·4
2	,,	6,500	1·037	3·2	15·7
3	,,	7,200	1·039	5·6	18·3
4	,,	5,500	1·042	4·3	21·6
	Chorionic gonadotropin				
5	6,000 I.U.	6,500	1·042	4·4	26·0
6	6,000 I.U.	5,700	1·044	5·9	28·0
7	6,000 I.U.	5,300	1·044	5·5	26.0
8	2 × 6,000 I.U.	5,900	1·041	7·0	34·8
9	None	5,600	1·040	4·6	24·3
10	,,	6,600	1·042	5·5	20·3
11	,,	6,300	1·038	6·9	17·2

* Calculated as œstradiol-17-β.

More detailed results of investigations in progress will be published elsewhere.

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Influence of Starvation and Glucose Load on the Activity of Liver Phosphorylase in Normal and Adrenalectomized Rats

RECENTLY, it has been shown by Sutherland *et al.*[1,2] that liver phosphorylase is acted on by two different enzymes. They found that the inactivation of liver phosphorylase was caused by an enzyme which appeared to be a phosphatase able to split off phosphate from active liver phosphorylase and thus render it inactive. Furthermore, they were able to demonstrate the existence of another enzyme able to reactivate inactive phosphorylase. In an earlier work, Sutherland and Cori[3] showed that epinephrine and glucagon play an essential part in the activation of liver phosphorylase, and evidence has since been established for the assumption that epinephrine and glucagon are reacting in some way or other with the reactivating enzyme. The complete mechanism has not yet been worked out, although a recent paper published by Rall, Sutherland and Berthet[4] has elicited the problem further.

The present experiments were carried out to study the phosphorylase activity in livers from different groups of rats. Phosphorylase activity was measured by the phosphate release method. Diluted homogenates were incubated at 37° with a reaction mixture of the same composition as that used by Sutherland *et al.*[5]. Besides glucose-1-phosphate the reaction mixture contained muscle adenylic acid, glycogen and sodium fluoride. The reaction mixture was adjusted to *p*H 6·1 with hydrochloric acid. Activity was expressed as the amount of phosphate released in 20 min. per mgm. nitrogen in the homogenate sample transferred to the reaction mixture. Only male rats were used, their weights ranging between 150 and 250 gm. All rats were anæsthetized with nembutal. The adrenalectomized rats were maintained on sodium chloride in the drinking water, and they were not used before three weeks after the operation. The liver samples were homogenized in physiological saline exactly two minutes after removal. Precisely four minutes after liver biopsy, the enzyme reaction was started by the addition of diluted homogenate to the reaction mixture. With intervals of five minutes, another four samples were taken from the diluted homogenate for activity determinations. By this procedure it was possible to measure the rate of inactivation in the diluted homogenate, which was placed in a water bath at 25°. The inactivation was in all cases linear for the first ten minutes. The decrease of activity during the first ten minutes in percentage of the initial value was taken as a measure of the inactivation.

It was found that fasted rats had lower phosphorylase activity than non-starved animals. A decrease in the rate of inactivation parallel to the decrease in phosphorylase activity was also noted (Table 1).

Table 1

	Group No.	No. of animals	Activity of phosphorylase (γ P/mgm. N)	Rate of inactivation (per cent)
Normal, non-fasted	1	15	636·1 (61·7)	50·7 (6·7)
Normal, fasted 20 hr.	7	12	594·9 (107·2)	34·7 (10·7)
Normal, fasted 48 hr.	8	9	378·5 (93·5)	25·3 (9·6)

Standard deviation is given in brackets

It is already known that the phosphorylase activity in livers from adrenalectomized rats is decreased[6]. This is confirmed in the present study. Furthermore, a pronounced fall of activity in the fasted adrenalectomized animals as compared with the non-fasted ones was demonstrated. Also in the case of adrenalectomized rats it was found that the rate of inactivation was decreased in the group of fasted animals with decreased phosphorylase activity (Table 2).

Table 2

	Group No.	No. of animals	Activity of phosphorylase (γ P/mgm. N)	Rate of inactivation (per cent)
Adrenalectomized, non-fasted	10	12	477·2 (87·8)	39·3 (5·6)
Adrenalectomized, fasted 20 hr.	11	8	310·2 (28·8)	15·5 (3·7)

Standard deviation is given in brackets

Sutherland *et al.*[2] mention that the process of inactivation–reactivation is very fast and assume that all phosphorylase in the liver could be reactivated in a few minutes. It seemed of interest to study the possible influence of induced hyperglycæmia on the activity of liver phosphorylase in the intact animal and therefore some short-time experiments on animals loaded with glucose were performed. The glucose was administered either per os in a stomach tube or intravenously in a femoral vein. Liver biopsy was carried out 20–30 min. after the glucose had been administered. The intravenous-treated rats had blood-sugar values about 300 mgm. per cent and the peroral-treated animals had blood-sugar values about 200 mgm. per cent when liver biopsy was done. The results of the experiments are given in Table 3.

It was noted that phosphorylase activity was decreased when the animals were treated with glucose. The decrease in the case of group 2 is not significant. The differences in the remaining four experiments are statistically significant as compared with the untreated groups. Adrenalectomized rats were the most sensitive, and fasted animals were more sensitive than non-fasted ones. The rate of inactivation was found to increase in the glucose-treated groups 9 and 20, where a rise in mean values of about 50 per cent is registered.

It is not possible to draw definite conclusions from the experiments mentioned; but the results seem

Table 3

	Group No.	No. of animals	Glucose administration	Activity of phosphorylase (γ P/mgm. N)		Rate of inactivation (per cent)	
Normal, non-fasted	1	15	—	636·1	(61·7)	50·7	(6·7)
Normal, non-fasted	2	7	oral	609·7	(55·5)	52·7	(8·9)
Normal, non-fasted	17	10	intravenous	546·7	(87·7)	54·7	(10·8)
Normal, fasted 20 hr.	7	12	—	594·9	(107·2)	34·7	(10·7)
Normal, fasted 20 hr.	9	8	oral	451·5	(42·2)	51·8	(8·2)
Normal, fasted 20 hr.	20	11	intravenous	429·5	(56·3)	49·4	(8·9)
Adrenalectomized, non-fasted	10	12	—	477·2	(87·8)	39·3	(5·6)
Adrenalectomized, non-fasted	22	8	intravenous	300·1	(70·1)	43·5	(9·4)

Standard deviation is given in brackets

to indicate that the inactivation–reactivation mechanism of liver phosphorylase is of great importance in the regulation of the glucose uptake and glucose output of the liver. A more detailed report and discussion will appear later in Reports of the Steno Memorial Hospital and the Nordisk Insulinlaboratorium.

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Development of Chemical Thermoregulation in Piglets

Husbandry experience and experimental work indicate that in the first two weeks it is generally not possible to rear piglets successfully in a cold or draughty environment.

These facts prove that there is a non-effective thermoregulation mechanism in piglets. During repeated studies of development of this mechanism in piglets, body temperature is usually used as an indicator. This criterion for solving this question is far from satisfactory and, because it cannot uncover the mechanism of thermoregulation, we decided to study the development of consumption of oxygen in piglets at varied ambient temperatures.

Large White bred piglets of both sexes, reared under infra-red lamps at a temperature of 15–18° C., were used for experiments. The procedure was as follows: piglets were kept singly for 30 min. at a temperature of 23 ± 1° C., then at 3 ± 1° C., and again at a temperature of 23 ± 1° C. At the end of each of these periods, the rectal temperature of the piglets was read. In the first two periods the oxygen consumption was measured by a Krogh respirometer (Tables 1, 2 and 3).

The finding of decreased consumption of oxygen during postnatal development confirms findings which were made earlier[1,2].

The fact that even on the sixth day the piglets do not react to decreased environmental temperature through increased metabolism proves that their thermoregulation system is immature. Further proof of this fact is that the temperature of the body greatly decreases in cold, and after a 30-min. stay in warmth it has not yet returned completely to its initial value. Also, the vasomotor reaction based on contraction of skin vessels in this period fails and after five minutes in the cold the piglets are cyanotic. Pilomotor reaction—bristling—and shivering of muscles appear in this period. Both mechanisms are clearly insufficient. Not until the ninth day of life is there improvement of homeothermism. Around the twentieth day the piglets attain the further degree of maturity of thermoregulation.

Attention has frequently been directed to the relation between body-weight of piglets and thermoregulation. To make clear this relation we separated piglets, the oxygen consumption of which was measured between the sixth and tenth day, into two groups. Into the first group we put those individuals which reacted to cold environment by increased oxygen consumption, and into the second group, those which did not have this reaction. Weight differences between groups were not significant, even though piglets which had the same oxygen consumption in cold and warm environments were on the average lighter. The difference in oxygen consumption of the 6-day old piglets and the 9-day old piglets was statistically significant. Therefore, it is necessary

Table 1. Consumption of Oxygen in Piglets in Environments of Varied Temperatures according to Age

Age of piglets (days)	Number of measurements	Consumption of O_2 in ml./kgm./min. in environmental temperature of 23±1° C.	3±1° C.	P
3	7	20·2±3·1	15·9±5·1	>0·1
4–5	6	19·2±8·3	17·4±7·9	>0·6
6	7	16·4±3·6	16·4±2·9	1·0
9–10	14	14·9±2·7	23·3±4·6	<0·01
12–13	13	17·5±3·5	25·7±3·4	<0·01
16–17	12	15·7±3·6	20·9±4·9	<0·02
20	14	17·3±6·2	26·1±8·1	<0·01
23	7	11·2±3·3	30·3±6·3	<0·01
27	7	19·0±5·1	33·4±4·3	<0·01

Table 2. Decreasing Body Temperature of Piglets in Environment of Varied Temperatures

Age of piglets (days)	Number of measurements	Decrease in body temperature in °C. in 30 min. at temperature of 3±1° C.	in further 30 min. at temperature 23±1° C.
3	7	1·8±0·14	0·8±0·17
6	14	1·8±0·25	0·8±0·18
9–10	14	1·2±0·19	0·6±0·11
12–13	13	0·8±0·16	0·5±0·03
16–17	15	0·8±0·15	0·6±0·11
20	13	0·4±0·02	0·3±0·02
23	7	0·4±0·13	0·1±0·12
27	7	0·5±0·02	0·2±0·02

Table 3. Consumption of Oxygen in Piglets between Sixth and Tenth Day of Life and its Relation to Body-weight in Environment of Various Temperatures

Number of measurements	Body-weight of piglets (kgm.)	Consumption of O_2 in ml./kgm./mir. in environmental temperature of 23±1° C.	3±1° C.	P
12	2·59±0·769	17·3±3·2	17·3±3·0	1·00
16	2·85±0·412	14·6±2·5	24·4±4·0	<0·01

to consider age as a more important factor than body-weight.

Experiments were carried out on piglets suckling regularly. As we discovered, even though intake and digestion of foods in piglets are important factors in metabolism, they cannot significantly influence the reported findings[2].

In conclusion it can be stated that development of chemical thermoregulation in the postnatal period of piglets occurs in three phases. Up to sixth-day thermogenesis, even if it exists, is unsatisfactory; from the ninth day it starts asserting itself, and around the twentieth day it is nearly perfect.

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Glucuronic Acid Formation in Epiphyseal Cartilage Homogenate

In a previous communication[1] the formation of hexosamine in epiphyseal cartilage homogenate of young rabbits was reported.

Cartilage was shown to synthesize the amino-sugar from glucose-6-phosphate and glutamine. The enzymatic fixation of sulphuric and acetyl radicals by cartilage has been reported by other workers[2,3]; we then envisaged the presence of all the enzymes concerned in chondroitin sulphate biosynthesis, inasmuch as chondroitin sulphate is largely present in cartilage and possibly connected with the fixation of calcium ions during the mineralization process.

Strominger *et al.*[4] have shown that the formation of glucuronic acid is accomplished through oxidation of uridine diphosphoglucose to uridine diphosphoglucuronic acid. This dehydrogenase was shown to be dependent on DPN+ and was isolated from calf liver by Strominger *et al.*[4].

We were therefore interested to see whether this enzyme was present in epiphyseal cartilage.

Epiphyseal cartilage of growing rabbits was used; the tissue was excised from proximal and distal ends of long bones at 0° C. and homogenized with cold water in a Potter–Elvehjem homogenizer. Two 10-ml. centrifuge tubes were used, each containing: 0·5 ml. cartilage homogenate (10 per cent), 1·5 ml. 0·014 *M* phosphate buffer *p*H 7·4, 20 μM magnesium chloride, 1 μM DPN+ and 1 μM of uridine diphosphoglucose (Sigma Chem. Co.). One tube immediately put in boiling water for 10 min. was taken as a blank; the other tube was incubated at 38° C. for three hours and the reaction was blocked as in the blank tube. In both tubes chondroitin sulphate was precipitated by the addition of 1 ml. of acetic acid and 2·5 ml. of ethanol (95%), and glucuronic acid was measured on the supernatant with the method of Dische[5].

Furthermore, we have studied the glucuronic acid formation omitting in the reaction mixture magnesium chloride or DPN+ or uridine diphosphoglucose, as well as replacing the last-named with uridine triphosphate and glucose-1-phosphate.

Table 1. Glucuronic Acid Formation in Epiphyseal Cartilage Homogenates

Values obtained in 3 hr. at 38° C. and *p*H 7·4 for 100 mgm. of cartilage

No. exper.	DPN+ μM	$MgCl_2$ μM	UDPG μM	UTP μM	Glucose-1-P μM	Glucuronic acid μgm.
11	1	20	1	—	—	136
2	1	—	1	—	—	110
4	—	20	1	—	—	52
6	1	20	—	—	—	12
2	1	20	—	2	3	100

In Table 1 average values of some experiments are collected.

From Table 1 it appears that uridine diphosphoglucose is oxidized to uridine phosphoglucuronic acid by cartilage homogenate: the dehydrogenase which is responsible for this oxidation is dependent on DPN+, as reported by Strominger *et al.*[4], since omission of this nucleotide in the reaction mixture yields a reduced formation of glucuronic acid. Uridine diphosphoglucose may be substituted by uridine triphosphate and glucose-1-phosphate: this observation indicates that uridine diphosphoglucose can be synthesized from these compounds according to the reaction[6]:

Uridine triphosphate + glucose-1-P → uridine diphosphoglucose + pyrophosphate

The capacity of cartilage to synthesize uridine diphosphoglucose is further support of the hypothesis that all the enzymes concerned in chondroitinsulphate biosynthesis are present in epiphyseal cartilage.

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Lipotropic Action of Ethyl Trichloracetate

During a study of the biological effects of halogen derivatives of aliphatic acids, the effects of ethyl monochloracetate and ethyl trichloracetate on rat liver have been compared. Ethyl monochloracetate has a toxic effect on liver, whereas equimolecular doses of ethyl trichloracetate cause no apparent change. However, when ethyl trichloracetate is given subcutaneously to choline-deficient rats, the high level of liver lipid is significantly reduced.

Young rats were placed on a basic choline-deficient diet containing 8 per cent casein, 12 per cent gelatin, and 12 per cent fat, the diet being essentially similar to that used by Ridout, Lucas, Patterson and Best[1]. After 21 days, a group of animals was given six subcutaneous injections of 0·1 ml. of ethyl trichloracetate (approx. 720 μmoles) per 100 gm. body-weight over three days. Control animals and injected animals were killed after 24 days on the basic diet. Mean lipid content of livers from the control group was 18·6 per cent wet weight of liver and 9·6 per

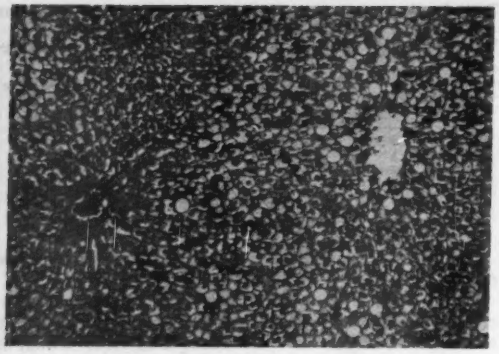

Fig. 1. Liver from choline-deficient rat. Hæmotoxylin and eosin. (×80)

cent for the injected group. This difference was statistically significant by the t test ($P < 0.02$).

In another experiment, a group of twenty-four rats was placed on the choline-deficient diet. After 3 weeks, half the animals were given a weekly dose of 0·7 ml. ethyl trichloracetate in divided doses for 4 weeks. Control animals and those injected were killed after 7 weeks on the diet. The mean liver lipid content was 14·2 per cent wet weight of liver for the control group, while for the treated group the mean value was 7·5 per cent. This difference was significant ($P < 0.001$).

Histological examination of livers of the choline-deficient group showed the accumulation of lipid in large and small globules about the centrolobular areas. This follows the usual pattern as described by Hartroft[2]. A section from a typical choline-deficient animal from the second experiment is shown in Fig. 1. The lipid content of this liver was 12·9 per cent. Livers from animals on the choline-deficient diet and receiving ethyl trichloracetate showed little fat in histological sections. Some livers showed a few large globules but usually the fat was present in such minute globules that it could not be recognized in routine hæmotoxylin and eosin sections. The histological appearance (Fig. 2) resembles that of normal liver, and the biochemical estimation of lipid in this liver was 6·2 per cent.

This lipotropic action of ethyl trichloracetate is of interest because of its chemical relationship to ethyl monochloracetate and the high toxicity of the latter.

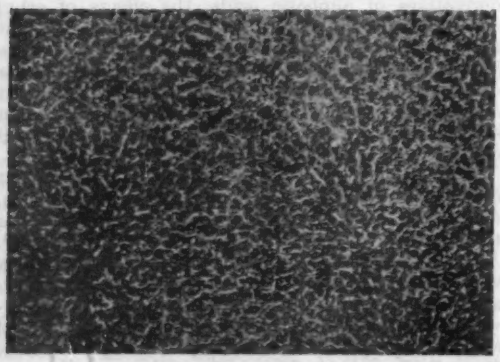

Fig. 2. Liver from choline-deficient rat injected with ethyl trichloracetate. Hæmotoxylin and eosin. (×80)

Publication of the complete results will follow this preliminary communication.

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Chemical Nature of the Fluorescent Pigment produced in *Microsporum*-infected Hair

Since Margarot and Deveze[1], studying tinea capitis in man, discovered in 1925 that infected hairs would fluoresce upon exposure to ultra-violet light, extensive use has been made of this phenomenon both in diagnosis and in evaluating the progress of therapy. In spite of numerous studies of the properties of the fluorescent pigment[2–6], the chemical nature of the fungus metabolite responsible for fluorescence has not been discovered.

Microsporum canis Bodin and *M. gypseum* (Bodin) Guiart and Grigorakis were grown upon hair, which was moistened with a small quantity of distilled water and sterilized by autoclaving, and also upon the synthetic medium of von Mallinckrodt-Haupt and Carrié[3], for three to four weeks at room temperature. Fluorescence was never directly observable upon either medium. The fungus-infected hair was thereupon extracted with water by autoclaving for 15 min.[2]. Charcoal was added to the aqueous extract, and was removed by filtration[3]. To the charcoal was added a small quantity of methanol[3]. The methanol solution, after filtration to remove the charcoal and concentration by evaporation, was passed through a 1 cm. × 8 cm. column of alumina[6]. Culture filtrates from the synthetic medium were treated similarly. The resulting methanol solutions were strongly fluorescent, the intensity of fluorescence from infected hair being several times as great as that resulting from cultivation of the fungi on the synthetic medium.

Absorption spectra of the methanol solutions in the ultra-violet were taken with a model *DU* Beckman spectrophotometer. For both *M. canis* and *M. gypseum*, two absorption maxima were present, a larger one at 260–275 mμ and a smaller one at 330–335 mμ. Absorption spectra of the extract from *M. gypseum* in $N/10$ hydrochloric acid showed peaks at 260 and at 335 mμ, while in $N/10$ sodium hydroxide these were shifted to 280–285 mμ and to 350 mμ respectively. These characteristics indicate that the pigment is a pteridine[6], an inference which finds considerable support in the chemical studies of Davidson and Gregory[2] and Chattaway and Barlow[7], and the infra-red analysis of Robinson, Figge and Bereston[6].

Methanol solutions of the fluorescent pigments from *M. canis* and *M. gypseum* were chromatographed on strips of Whatman No. 1 filter paper by the ascending technique, using 3 N ammonium hydroxide or the organic phase of n-butanol : acetic acid : water (4 : 1 : 5, by volume) as the developing solvents. The

spots were located by their fluorescence. For both *M. canis* and *M. gypseum*, a single spot was obtained with R_F values in the two solvents of 0·79–0·83 and 0·67–0·71 respectively. These findings would indicate that the fluorescent pigments of the two species of fungi are identical.

The fluorescence spectra of methanol extracts of *M. canis* and *M. gypseum* were studied with a model *DU* Beckman spectrophotometer modified by having the sample tube in the position of the usual light source. Excitation was provided by a General Electric 100-watt mercury lamp, type *S*-4. Fluorescence maxima for both species were found at 455–460 mμ, a value which differs considerably from that reported by Bereston and Crosswhite[8].

The properties of the fluorescent pigment produced by *M. canis* and *M. gypseum* indicate that it is a pteridine. Efforts to identify it with a known pteridine have been unsuccessful.

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Complexity of the Vanadium - Hydrogen Peroxide System

THE reaction of quinquevalent vanadium with hydrogen peroxide, which is a well-known spot test[1] and the basis of a colorimetric[2] and volumetric[3] method for the estimation of vanadium, becomes rather complex on closer inspection. Depending upon concentrations and temperature of the reactants, this reaction can lead to four distinctly different forms.

(1) In alkaline solutions, concentrated in vanadium and hydrogen peroxide, the blue-violet tetraperoxy-orthovanadate ions[4,5] are formed in the cold relatively slowly :

$$VO_4^{3-} + 4H_2O_2 = (V(O.O)_4)^{3-} + 4H_2O$$

(2) An intermediate formed instantly in the above reaction is the yellow diperoxy-orthovanadate ion, $(VO_2(O.O)_2)^{3-}$, which is stable in dilute, weakly alkaline to weakly acidic solutions of alkalivanadates[5].

(3) In acidic solutions, the pale yellow pervanadyl ion[6–8], VO_2^+, instantly forms the deep red-brown monoperoxy-pervanadyl cation, $(VO(O.O))^+$:

$$VO_2^+ + H_2O_2 = (VO(O.O))^+ + H_2O$$

forms (2) and (3) being related by the equilibrium :

$$(VO_2(O.O)_2)^{3-} + 4H^+ = (VO(O.O))^+ + H_2O_2 + H_2O$$

(4) In strongly acidic solutions, on the other hand, a reduction[5,9] to the blue quadrivalent vanadyl ion, VO^{2+}, takes place relatively slowly :

$$2VO_2^+ + 2H^+ + H_2O_2 = 2VO^{2+} + 2H_2O + O_2$$

the red-brown $(VO(O.O))^+$ ions being formed instantly as an intermediate. The reduction occurs quantitatively and within a few minutes in concentrated sulphuric acid, and more slowly in 72 per cent sulphuric acid, or 72 per cent perchloric acid. It can be seen from Fig. 1 that heating up to 81° C. does not interfere with the quantitativeness of reduction. In dilute acidic solutions, reduction occurs considerably more slowly and is no longer quantitative, solutions in nitric acid showing less readiness to undergo reduction than those in sulphuric or perchloric acids of corresponding strengths.

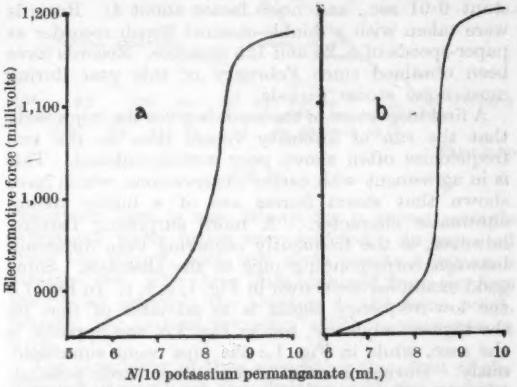

Fig. 1. Oxidation curves of VO^{2+} solutions with *N*/10 potassium permanganate after reduction with hydrogen peroxide (*a*) at 21° C. and (*b*) at 81° C. 0·1000 gm. ammonium vanadate was dissolved in 30 ml. 72 per cent sulphuric acid (w/w) in each case

When reversing the order of mixing, that is, first dissolving the vanadium (V_2O_5, or NH_4VO_3) in hydrogen peroxide (100 per cent by volume) and then acidifying the ensuing yellow solution of $(VO_2(O.O)_2)^{3-}$ relatively slowly with concentrated sulphuric acid, a reduction to the blue VO^{2+} ion occurs quantitatively within a few minutes. We therefore recommend this procedure as basis of a selective method for the volumetric determination of vanadium.

It is evident from this review of the vanadium–hydrogen peroxide system that a colorimetric estimation of vanadium will require a low concentration of hydrogen peroxide, medium to low acidity (nitric acid in preference to sulphuric or perchloric acid), and a relatively low temperature. Similar considerations would apply to the spot test technique.

Detailed results of our investigation will be published elsewhere. We wish to acknowledge financial assistance from the British Cotton and Wool Dyers' Association and aid in apparatus from Imperial Chemical Industries, Ltd., Blackley.

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Frequency Drift of Short-Time Transients in Solar Radio Noise

A DETAILED knowledge of the structure of solar noise storm bursts is essential for a theoretical treatment and understanding of the phenomenon. Different methods of observation have been tried in order to secure information on important physical quantities of storm bursts. In this communication some preliminary results are reported from an analysis of high-speed records which were taken with a receiver containing two channels centred at 199 Mc./sec. and 200·5 Mc./sec. (band-width: 0·3 Mc./sec., time constant 0·01 sec., and noise factor about 4). Records were taken with a double-channel Brush recorder at paper-speeds of 5, 25 and 125 mm./sec. Records have been obtained since February of this year during most noise storm periods.

A first inspection of the records gives the impression that the run of intensity versus time on the two frequencies often shows poor correspondence. This is in agreement with earlier observations, which have shown that storm bursts are of a highly monochromatic character. A more surprising feature, however, is the frequently occurring time difference between corresponding pips in the channels. Some good examples are shown in Fig. 1, *a*, *b*, *c*. In Fig. 1,*a* the low-frequency signal is in advance of that on the higher frequency, but in Fig. 1,*b*, the opposite is the case, while in Fig. 1,*c* the pips occur simultaneously. During a noise storm these three possibilities are all realized, but in different proportions. On April 28, out of 87 pairs of pips, 42 occurred at first on the low frequency, 29 occurred first on the high frequency, and 16 occurred simultaneously.

The simplest way to explain the observations is to suppose that the transients in most cases have a frequency drift from higher to lower frequencies, or vice versa. If this is assumed, observations indicate drift velocities in either direction ranging from about 10 Mc./sec.[2] and upwards to rather high values.

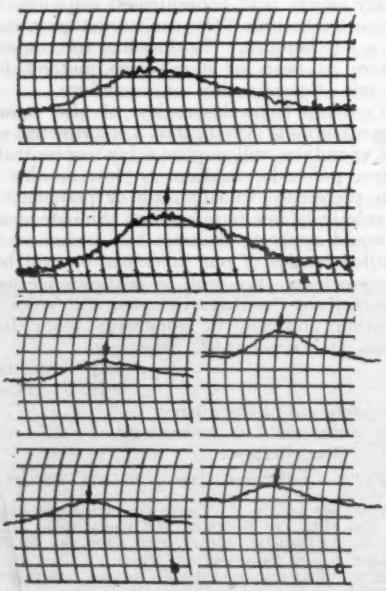

Fig. 1. Examples of records. (Paper speed 125 mm./sec., lower-frequency above.) In (*a*) the pip occurs first on the low frequency, in (*b*) on the high frequency and in (*c*) simultaneously in both channels

Observations by Wild[1] with a spectrometer covering the frequency range 70–130 Mc./sec. showed that noise storm bursts had a mid-frequency which remained approximately constant throughout their life-time. However, since the rather extended spectral range covered was only displayed about three times a second, the instrument was not fitted for observations of transients with a duration less than, say, 0·5 sec. and a drift over only a few megacycles/second. This may be the reason why the effect dealt with here has not been reported earlier. The mean duration of the pips which were recorded with the two-channel receiver was of the order of 0·30 sec. A narrow-band spectrometer with a high frequency of repetition has now been erected at the Solar Observatory.

A fuller analysis of the records from the double-channel receiver is in preparation and the results will soon be published.

This investigation is being supported in part by the U.S. Air Force (ARDC, European Office).

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Strength of Highly Porous Brittle Materials

THE experimental scatter in strength measurements of brittle materials is now accepted as reflecting the inherent statistical nature of this type of failure rather than an excessive sensitivity to measuring methods. Moreover, some characteristic features of brittle bodies, such as the scale effect, whereby geometrically similar test pieces of different absolute size give significantly different results, are easily explained on a statistical basis.

The fundamental work on these questions has been done by W. Weibull and by J. I. Frenkel and T. A. Kontorova, who base their theory on a random distribution of microscopic flaws in the material. These flaws weaken the material in their vicinity to different extents, the most 'dangerous' flaw determining the macroscopic strength of a homogeneously stressed test piece. At the back of these ideas is the old theory of 'Griffith's cracks', which are the cause of local stress concentrations, the severity of which depends on the size of crack.

These theories are satisfactory if they are to explain only the statistical nature of brittle fracture. The notion of a flaw, however, is too vague to give a clear-cut relation between the inherent strength of the material and the weakening effect of these flaws. The Griffith's crack, it is true, does give such a relation, but it forms a very special type of flaw; the number of such cracks per unit volume of the material is, moreover, usually assumed to be so low that the stress concentration in the neighbourhood of one is not affected by the presence of another crack. Neither the shape nor the concentration of

Griffith's cracks can be taken to form a reasonably correct model for highly porous materials such as, for example, set plaster of Paris. (This does not affect, of course, the validity of Griffith's crack theory in some individual crystals.)

On the assumption that the flaws which give the strength its statistical character are pores, a further development must, if possible, generalize with respect to shape of pore and porosity (percentage of void space in 1 c.c.). The difficulty lies in the fact that shapes of pores can be very complicated indeed. Set plaster of Paris, for example, can form a felted mass of acicular crystals with a very high porosity. The pores are interconnected and very different from any simple geometrical shape.

Progress was found possible by working out the results for a body riddled with a number of spherical pores and also for one which is permeated with tubular pores which twist and turn in a random fashion. The former can be taken as also approximately true for shapes which have roughly equal dimensions in all directions, while the latter is also approximately true for pores the dimension of which in one direction is much greater than in any direction at right angles to it. These two results, therefore, cover two very different types of pore shapes. Surprisingly, the two resulting formulæ have a very striking similarity and suggest a generalization which contains the derived formulæ as special cases. It is impossible to give here the mathematical derivation, which is rather lengthy and will be published elsewhere; but the essential result is the following relation between strength and porosity:

$$S = q \log \frac{p_{cr}}{p}$$

where S is the measured strength and p the porosity; q and p_{cr} are two constants referred to as the quality factor and critical porosity. It is a consequence of the theory that q may be interpreted as a measure for the inherent strength of the skeleton, while p_{cr} is the critical porosity at which the material would lose all strength. This latter constant is a geometrical feature of the pore system and, therefore, independent of the type of test; q, on the other hand, in accordance with the general behaviour of solid bodies with respect to mechanical strength, will assume different values for different tests.

In the case of set plaster, it can be shown that the porosity may be regarded as entirely due to the evaporation of the quantity of water in excess of that required for the complete hydration of the hemihydrate ($2CaSO_4.H_2O$) from which the plaster mix was made. The corrections which are, strictly speaking, required to allow for setting expansion (of the order of ½ per cent) and similar effects are small. The above formula has been verified by the results of strength tests on a considerable number of plasters differing in origin, method of calcining, conditioning of the set specimen, etc. The most convenient way of making comparison between theory and experiment is by plotting measured strengths against the logarithm of the porosity. The abscissa also carries a scale of water ratios (c.c. water per gm. of plaster used for the mix).

Fig. 1 represents the experimental results of compressive, transverse and tensile tests for a plaster, four water ratios having been taken for each type of test. The modulus of rupture as obtained from the

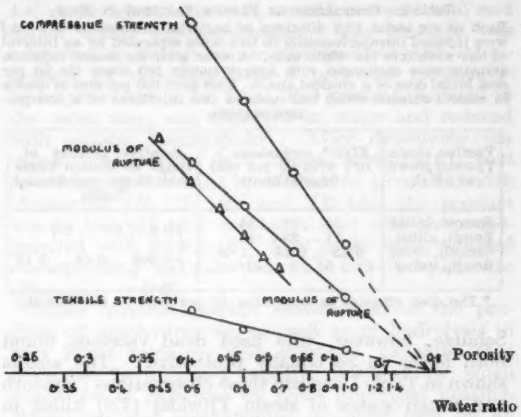

Fig. 1

transverse test is also shown for a second sample where six water ratios were selected. As expected from the theory, each test gives results lying on a straight line. The three lines obtained from the first sample all intersect the abscissa at the same point, namely, the critical porosity, which in this case is 0·79.

The possibility of thus separating the effect of the inherent strength of the skeleton and the porosity promises to be of great practical value.

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A Protein Antigen associated with Smooth Colony Forms of some Species of *Pasteurella*

On the basis of serological studies, *Pasteurella pestis* has been considered to be antigenically 'rough'[1], a view which is confirmed by the absence of an 'O' somatic antigen[2]. Virulent and certain avirulent plague strains, however, produce smooth colonies although rough strains also occur[2]. The rough forms referred to herein correspond to *'TSR'* and not *'TRU'*[4].

Analysis of the antigenic compositions of smooth and rough strains by the agar diffusion method of Ouchterlony[5] revealed that an antigen (antigen 4)[4] is present only in smooth forms and in maximal amount in well-aerated broth cultures incubated at 37° C. and at a *p*H close to neutrality. It is first detected after about 16 hr. of growth, and production reaches a maximum at the end of the log phase. It is not formed in detectable amounts by static broth or agar surface cultures. Although smooth and rough avirulent protective strains have not previously been differentiated antigenically, Otten[3], using living vaccines, showed that smooth strains gave better protection than those which were rough;

Table 1. Comparison of Plague Vaccines in Mice

Each of six serial 1:2 dilutions of bacterial suspensions (0·5 ml.) were injected intraperitoneally in two doses separated by an interval of one week into ten white mice. A week after the second injection animals were challenged with approximately 100 times the 50 per cent lethal dose of a virulent strain. This gave 100 per cent of deaths in control animals which had received two injections of a non-protective strain

Vaccine, strain Tjiwidej grown at 37° C.	ED50* (organisms × 10^6) with 95 per cent fiducial limits	Relative potency of rough to smooth forms with 95 per cent fiducial limits
Smooth, killed	16 .. 32 .. 64	0·3 .. 0·7 .. 1·7
Rough, killed	11 .. 23 .. 43	
Smooth, living	0·23 .. 0·38 .. 1·08	0·008 .. 0·04 .. 0·13
Rough, living	5 .. 9 .. 42	

* The dose effective in protecting 50 per cent of the animals.

Schütze, however, who used dead vaccines, found both forms to be equally protective[2]. The results shown in Table 1 confirm these observations; smooth and rough states of strain Tjiwidej (*TS*) killed in acetone at − 20° C. do not differ significantly in protective value, indicating that they contain similar amounts of protective ('envelope') antigen. Living rough cultures give a similar degree of protection to those which have been killed; but living smooth cells give between 20- and 100-fold better protection than smooth organisms killed in the same way. Similar results have been obtained for smooth and rough pairs of strains other than *TS*. Since antigen 4 is the only difference in antigenic constitution which can be detected between smooth and rough strains, the results suggest that antigen 4 contributes to the survival of smooth organisms *in vivo*, thus prolonging the stimulus for protective antibody production. On this basis the results of Walker *et al.*[6], who studied protective values and survival-times *in vivo*, suggested that strain 14 possessed antigen 4 but no protective antigen. No strain of this type had previously been encountered, but examination of the culture has shown this induction to be correct.

Antigen 4 has been isolated from saline extracts of smooth *P. pestis* cells by precipitation with ammonium sulphate (15–23 per cent saturation). A preparation which satisfies the usual criteria of physical homogeneity is shown (Fig. 1) to pass, in addition, a most sensitive test for immunological homogeneity. The material is a protein, but unlike the 'envelope'[4] or antigen 3 does not induce production of protective antibodies, although it is much more potent as an antigen when the two purified materials are compared. Whereas smooth cultures are relatively stable in saline suspension, rough cells rapidly sediment. The addition of a purified preparation of antigen 4 to a suspension of rough organisms has a stabilizing effect such that they sediment no more rapidly than smooth ones. This effect could not be obtained with any of several other proteins, some of which had been isolated from *P. pestis* cells. It seems likely, therefore, that antigen 4 is related in some way to the smooth colonial form of an organism which is rough in the Salmonella sense.

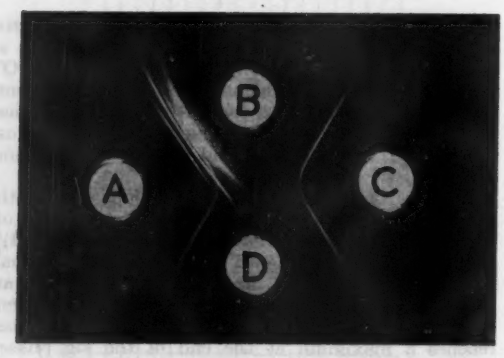

Fig. 1. Agar diffusion precipitin pattern of *Pasteurella pestis* cells and antigen 4. The antigen 4 preparation (*C*) gives only one line when reacting with an antiserum (*B*) which contains antibodies to all the antigens of smooth 37° C. grown organisms (*A*). Antiserum (*D*) prepared by immunization with the antigen 4 preparation reacts with these organisms (*A*) and antigen 4 (*C*) to give only one line. The arc on the right shows the specific identity of the antibody reacting from the serum at (*B*) and the monospecific serum at (*D*)

Whereas all smooth avirulent strains produced antigen 4 within 16 hr. under appropriate conditions, virulent strains did so only when growth was continued for a longer period. *Pasteurella septica* and *Pasteurella haemolytica* do not produce antigen 4, and judging from agar diffusion analysis their relationship to *P. pestis*, and indeed to one another, seems to be remote. *Pasteurella pseudotuberculosis*, however, shows a very close relationship to *P. pestis*[4,7]. All virulent *P. pseudotuberculosis* strains produced antigen 4 but neither smooth nor rough avirulent forms did so. It may thus represent a 'virulence' antigen in this species, although it is not a protective antigen in *P. pseudotuberculosis* infection. Smooth strains, unlike *P. pestis*, contain a specific smooth 'O' somatic antigen[8]. Strains which had lost their smooth 'O' somatic antigen and were smooth in colonial form have been encountered; these strains contained antigen 4, whereas frankly rough forms had lost both the 'O' somatic antigen and antigen 4.

We gratefully acknowledge the encouragement and advice of Dr. D. W. Henderson.

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The Gum of *Fagara xanthoxyloides*

Fagara xanthoxyloides Lam. (*Xanthoxylum senegalense* DC.), a common plant in West Africa, exudes a clear yellow gum during the dry season. The gum is partly acetylated and has a significant methoxyl content. A single unpurified nodule gave, on analysis, acetyl groups, 6·95 per cent; methoxyl groups, 2·6 per cent. The nodules dissolve with difficulty in water to give a viscous solution with a faintly acid reaction. The purified gum was obtained in the usual way[1], and after drying in a partial vacuum at 30° was a white amorphous powder, $[\alpha]_D^{21} + 4°$ (*c.* 0·5 in *N* sodium hydroxide); equivalent weight by direct titration, 1,100; sulphated ash, 0·25 per cent; nitrogen, 0·23 per cent; acetyl groups, none; methoxyl groups, 2·6 per cent (a polysaccharide of

equivalent weight 1,100 containing monomethylhexuronic residues would have a methoxyl content of 2·8 per cent). It gave a positive naphthoresorcinol test for uronic acid, and failed to reduce Fehling's solution. Specimens prepared from nodules from different trees did not show any significant differences in optical rotations and equivalent weights, indicating the essential homogeneity of the gum.

A 0·5 per cent solution of the gum in 2 *N* sulphuric acid was heated for 20 hr. in a sealed tube immersed in a boiling water bath. The solution was neutralized with barium carbonate and then concentrated under reduced pressure to small volume. On paper chromatograms including reference substances and run in the solvent systems *n*-butanol–ethanol–water (20 : 1 : 3) (*A*), *n*-butanol–pyridine–water (3 : 1 : 1) (*B*), benzene–*n*-butanol–pyridine–water (1 : 5 : 3 : 3) (*C*), the sugars galactose and arabinose were detected. The papers were developed with *p*-anisidine phosphate and naphthoresorcinol–trichloroacetic acid sprays. The absence of ketoses was established by means of the last-named spray developer. A portion of the neutral hydrolysate obtained above was deionized by treatment with 'ZeoKarb 225' and chromatographed with the solvent system, ethyl acetate–acetic acid–formic acid–water (18 : 3 : 1 : 4) (*D*). On developing with *p*-anisidine phosphate, 4-O-methylglucuronic acid was detected as a pink spot moving at the same rate on the chromatogram as rhamnose[2].

Another portion of gum was hydrolysed as above, and the neutral hydrolysate concentrated under reduced pressure to a syrup. This was repeatedly extracted with boiling methanol, and the methanol extracts concentrated under reduced pressure to a syrupy mixture of neutral sugars. The syrup was resolved on large sheets of Whatman 3*MM* paper, the appropriate portions of the paper eluted with cold water, and galactose $[\alpha]_D^{21} = +81°$, and arabinose $[\alpha]_D^{21} = +104°$, characterized as mucic acid, m.p. and mixed m.p. 214–215°, and arabinose benzoylhydrazone, m.p. and mixed m.p. 206–207° (from ethanol), respectively.

Because of the extensive decomposition brought about by boiling sulphuric acid, quantitative estimation of the sugars was carried out on the product obtained by hydrolysing a portion of gum with 98 per cent formic acid[3]. A 2 per cent solution of the gum in formic acid was heated on the steam bath for 11 hr. The solution was evaporated under reduced pressure to a syrup and heated with *N* sulphuric acid for one hour to hydrolyse formyl esters. The solution was neutralized with barium carbonate, concentrated to a syrup and chromatographed on large sheets of Whatman No. 1 paper, with solvent system (*A*), with descending development for 72 hr. The appropriate portions of the paper were eluted with cold water and the amounts of sugars present estimated by the sodium periodate micro method[4]. A galactose–arabinose molar ratio of 7 : 3 was obtained.

The acidic products of the hydrolysis of the gum with 0·5 *N* sulphuric acid (17 hr. in a boiling water bath, $[\alpha]_D$ changed from *c.* +4° to +86°) were isolated by pouring the neutralized hydrolysate, concentrated to small volume, into methanol. The precipitated material, after deionizing with 'Amberlite *IR* 120 (*H*)', was shown by chromatography with solvent (*D*) to consist of the barium salts of 4-O-methylglucuronic acid, an aldobiuronic acid and higher acidic oligosaccharides. The mixture was subjected to simultaneous methanolysis and esterification by refluxing with 8 per cent methanolic hydrogen chloride for 7 hr. The product, isolated in the usual way, was dissolved in water and reduced with sodium borohydride[5]. After destroying the excess borohydride with dilute acetic acid, and deionizing the solution by successive treatment with 'Amberlite *IR* 120 (*H*)' and '*IR* 4*B*', the product was hydrolysed with sulphuric acid and chromatographed with solvent *B*. Two spots were obtained corresponding to galactose and 4-O-methylglucose ($R_{\text{Rhamnose}} = 0·9$).

Paper chromatographic examination of the progress of autohydrolysis, as well as of hydrolysis in very dilute sulphuric acid solutions, indicated that arabinose is liberated rapidly, followed by small quantities of galactose on more prolonged heating. Hydrolysis was accompanied in every case by an increase in the positive optical rotation, corresponding to the splitting of β-linkages.

The gum of *Fagara xanthoxyloides*, therefore, appears to be composed of labile L-arabinose residues, linked to a more resistant framework of D-galactose and 4-O-methylglucuronic acid units, thus bearing a superficial resemblance to gum myrrh[2].

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Possible Occurrence of Strains in Species of Schistosomes

In a recent paper Cridland[1] has stated among his conclusions that there is no evidence for the occurrence of strains in human schistosomes and also that he had found that certain species of snail did not appear to act as carriers. For example, he states that *Bulinus africanus ovoideus* (Bgt.) will not act as a carrier of *Schistosoma haematobium* in Uganda, on the evidence that he had not been able to infect it in the laboratory. In the Kitui area of Kenya *Bulinus* (*Physopsis*) *africanus ovoideus* (Bgt.) and *B.* (*P.*) *nasutus* (von Marts.) both occur in ponds, dams and streams. The latter snail is common also in the coastal regions of north-east Tanganyika and is, in my opinion, quite different from the snail occurring in the Great Lakes which Mandahl-Barth[2] recorded as *nasutus*. He agrees with me that different sub-species are involved.

Bilharzia is frequent in the Kitui area of Kenya and *B. africanus ovoideus* has been demonstrated to be a carrier by the reliable method of identifying the adult worms. This was carried out by Drs. Teesdale and Nelson of the Division of Insect-Borne Diseases, Nairobi, with naturally infected material. This suggests, therefore, that either *B. africanus ovoideus* or *Schistosoma haematobium* or perhaps both exist in different strains. It seems more probable that the parasite exhibits strains but the species of *Bulinus* are rather plastic. The identification of the snails

has been checked by dissection and also confirmed by Dr. G. Mandahl-Barth.

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Anatomy of *Polystoma integerrimum*

The remarkable dimorphism of the monogenetic trematode *Polystoma integerrimum* has been the subject of a number of investigations, principally by Zeller[1,2] and Gallien[3]. The descriptions of the neotenic (branchial) form given by these authors show several important discrepancies, and in view of this a re-examination of the species was undertaken.

Previously undescribed details of the anatomy of the normal or bladder form are as follows:

The material from which the anchors are formed is produced by clusters of secretory cells. The caudal suckers are supported by radiating cuticular bars which pass through the tissue of the sucker wall. Cuticular rays are known to form part of an intricate framework supporting the sucker in related genera, but have not been observed in *Polystoma*.

A median intestinal process extends forward beneath the pharynx and communicates with the buccal tube, forming a continuous canal underlying the pharynx and œsophagus and providing an alternative passage between oral cavity and intestine. For this passage the term 'bucco-intestinal canal' is suggested. The animals occasionally expel intestinal contents through the bucco-intestinal canal when disturbed; perhaps residual products of digestion are normally voided from the gut in this manner. Vital staining with methylene blue reveals a complex nerve ring surrounding the canal.

The male and female genital ducts have a syncytial lining, which is ciliated except in the terminal portions of the female canal holding the shelled egg. The cilia penetrate to the base of the epithelium; their activity resembles the flickering motion of the flames of the excretory system.

The ovary comprises a small anterior proliferative zone and a large posterior portion in which ripe oocytes are stored. The posterior portion of the ovary has an epithelial wall; each of the oocytes is enclosed in a delicate envelope formed from membranous extensions of the free border of the epithelium.

Two distinct groups of unicellular glands are associated with the ootype. The cells of the smaller group produce a deeply staining secretion, and their ducts open in a restricted region at the proximal end of the ootype. The secretion may play some part in egg capsule formation. The cells of the larger gland mass form a coarsely granular secretion which is faintly cyanophilous and gives a strong positive reaction to Steedman's alcian blue test for mucin[4]. The numerous, tightly bunched ducts empty through the entire ootype wall. The lubricating property of the mucin may facilitate the moulding of the egg capsules and the passage of the shelled egg along the uterus.

In the neotenic adult also the anchors are formed from the product of small secretory cells, and the suckers are supported by cuticular rays. The bucco-intestinal canal is present in both the neotenic adult and the larva. The oocytes of the branchial form are enclosed in membranous envelopes continuous with the ovarian epithelium. Both types of unicellular gland associated with the ootype differentiate in the neotenic form.

The definitive spermatozoon of the neotenic adult resembles the late spermatid of the normal adult.

It was found during the present investigation that, contrary to earlier accounts, there is no communicating canal between the testis and the female ducts of the neotenic adult. The vas deferens is present as in the normal form; this duct was observed by Zeller but was not described by Gallien. Although not previously identified, the genito-intestinal canal is present and functional as in the normal adult. The vaginæ and long winding uterus of the bladder form are not represented in the branchial form.

The histological appearance of the genital ducts of the branchial form is similar to that of the corresponding ducts of the normal adult.

During normal development the uterus and vaginæ are the last of the genital ducts to be differentiated, and the young normal form closely resembles the neotenic adult.

Since there is no duct connecting male and female organs in the branchial form, internal self-fertilization does not take place. Sperm bundles are found in the female ducts of solitary neotenic adults, and therefore external self-fertilization must occur, insemination being effected through the ovo-vitelline duct. When two neotenic adults parasitize the same tadpole cross-fertilization through the gonopore may occur. Thus, *within the one species* the copulatory function presumably is transferred from the vaginæ to the ovo-vitelline duct as a result of neotenic development.

The completed study of the anatomy of *Polystoma integerrimum* will be published later, together with notes on the life-history and relationships of this species and observations on related genera.

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Potato Blight and Leaf-Roll Virus

Observations on the potato variety Ulster Supreme made at Cambridge in 1956 indicated that blight (*Phytophthora infestans*) was present on approximately twice as many tubers derived from plants infected with leaf-roll virus as on those from neighbouring virus-free plants (virus-free being used in this communication to mean free from visible symptoms of virus disease). The appearance of potato blight in August 1957 made possible an examination and comparison of the foliage of virus-free and leaf-roll infected plants. At an early stage in its development it was apparent that the primary foci of infection were often associated with patches of plants infected with leaf-roll virus and that some plants within these patches were completely destroyed at a time when surrounding virus-free plants were only slightly or moderately blighted. Leaves picked on three occasions from an area showing 50 per cent leaf-roll infection, from the same level of the crop

and showing no visible blight lesions, were incubated. On each occasion blight lesions developed on about half the rolled virus-infected leaves whereas none developed on those which were virus free.

Laboratory tests using leaf pieces sprayed with a zoospore suspension, as described by Müller[1], indicated that leaf-roll infected leaves were less susceptible to infection than virus-free leaves. Results of three tests gave 55 per cent infection on virus-free pieces and 37 per cent on leaf-roll pieces (the individual results being 84, 56, 26 and 67, 33, 11 per cent respectively). It was noted that the rate of advance of the fungus was much slower on leaf-roll infected leaflets than on virus-free ones. This condition is similar to that described by Müller and Munro[2] for potato leaves infected with virus *X* and virus *Y*. In addition, preliminary tests on tubers indicated that those infected with leaf-roll virus were not more susceptible to blight than those virus free.

Examination of potato foliage during bright periods following heavy showers showed that rolled leaf surfaces remained damp for longer periods than flat leaf surfaces and that many rolled leaflets held water to a depth of several millimetres until shaken out by the wind or slowly evaporated. It is suggested that the micro-climate of rolled virus-infected leaflets is more conducive to blight development for longer and more frequent periods than that of virus-free leaflets and that this is more than sufficient to overcome the slower rate of advance of the fungus on the former. Furthermore, the difference between micro-climates would account for the greater prevalence of blight on tubers derived from leaf-roll infected plants. Experiments to confirm this are in progress and will be reported elsewhere.

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Growth and Properties of Bacterial Protoplasts

Previous papers on the subject of bacterial protoplasts prepared by the action of lysozyme indicate that the authors have been unable to observe growth and division of these structures over a prolonged period[1-3], although indications of activity in this direction have been obtained[4,5].

From preliminary experiments performed in this laboratory, it appeared that the reason for this failure to grow lay in some factor inherent in the enzymatic method of protoplast release, inhibitory to active growth and division. A method was developed which permitted the release and prolonged growth of protoplasts of a wide range of bacteria without employing extracellular 'enzyme-stabilizing' systems[3]. Bacteria were grown in a fluid medium containing 3 per cent w/v α-amino acetic acid (glycine) in 4-ml. amounts in 15-ml. screw-cap bottles, rotated at 22 revolutions per hour. The initial *p*H of the medium was 7·0, and the incubation temperature was 34° C.

Bacteria sensitive to this treatment lost their cell walls in a few hours, and a dense growth of protoplasts was obtained in 18–24 hr. In many species no vegetative cells could be detected and the protoplasts so formed could be propagated for prolonged periods in pure culture, without the appearance of any vegetative cells.

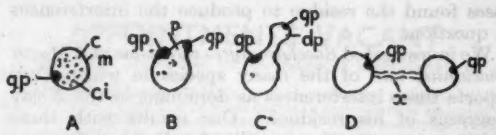

Fig. 1. *A*, Structure of protoplast (*g.p.*, growing point; *c.*, cytoplasm; *c.i.*, cytoplasmic inclusions; *m.*, membrane). *B–D*, Division of protoplast (*p.*, protrusion formed in early stages, swells at tip to form daughter protoplast, *d.p.*); the connexion between the two cells degenerating, *x*

The majority of studies were made upon *Vibrio cholerae*, *V. el Tor*, *Salmonella typhi*, *S. typhimurium*, *S. paratyphi* B. and a number of other bacteria of enteric origin.

By this method many of the properties of protoplasts have been investigated, and these are listed here very briefly.

(1) Membrane secretion, growth and division is controlled by a growing point granule consisting of lipoprotein in association with Feulgen-positive nuclear material[6] (Fig. 1).

(2) Reversion to vegetative forms, and further reorganization to the L-form, may be obtained under suitable conditions without difficulty.

(3) Diminution in size and increase in resistance to the inducing agent as serial subculture continued.

(4) Protoplasts have also been observed occurring naturally in pond and other natural waters, and as a response to senescence in laboratory cultures.

(5) The rate of fall of viable count in cultures of protoplasts rotated at 34° C. appears to be considerably less than in parallel cultures of homologous strains of *Vibrio cholerae* in the vegetative form.

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X-Ray Interferences of Barium Sulphate in Fungi and Algae

In a paper on the constitution of cell walls of fungi, R. Frey[1] concludes that several fungi and algae show in their cell contents or membranes an inorganic substance with an X-ray diagram corresponding to that of barium sulphate. Since, in our researches on cell-walls of fungi[2,3], X-ray interferences suggesting the presence of that substance were never observed, some further work was done in order to check Frey's statements.

Frey subjected his cultured fungi to a standard extraction procedure with alkali and then in most

cases found the residue to produce the interferences in question.

We investigated *Saccharomyces cerevisiae* and *Mucor rouxianus*, two of the many species in which Frey reports these interferences as dominant in the X-ray diagrams of his residues. Our results with these species were negative; neither by X-ray diffraction patterns of residues from extraction, nor by chemical analysis of the ashed fungi, have we been able to detect barium sulphate. For this and other reasons, in particular the occurrence of barium oxide in certain laboratory glasses and its solubility in alkali, it seems possible that Frey's observations on at least the fungi are due to contamination by the chemical treatment*.

Of the few algae investigated by Frey, *Spirogyra* was selected for a check. In this genus E. Nicolai (private communication to R. Frey and D. R. Kreger) has also observed X-ray interferences resembling those of barium sulphate, and she was the first to observe the phenomenon. The interferences were reported to appear in samples of dried natural filaments. Since these interferences cannot be due to contamination, we were interested in investigating this genus.

The X-ray diagrams of our *Spirogyra* samples likewise showed barium sulphate interferences.

We have tried to find if barium sulphate is actually the source of the interference lines. It could be shown both by X-ray diffraction of extracted material and of the ash and by chemical analysis of the latter that this substance is indeed present in the algae. The quantities amounted to 0·2–0·4 per cent of the dry weight. Algae from quite different types of fresh water contained such large amounts.

By examining separate cell walls and cell contents evidence was obtained that the mineral should not be regarded as part of the cell-wall, even though under certain artificial conditions its crystallites may show a preferential orientation with reference to the wall surface.

It may be noted that in higher plants barium is not an unusual minor element[4]. In a few species it has been found in amounts comparable to those mentioned above if the soils were rich in exchangeable barium[4]. The barium content of these plants roughly followed that of the soils, and therefore do not seem to be so much a result of accumulation as in *Spirogyra*.

Details of this research will be published elsewhere. The work has been supported by the Netherlands Organization for Pure Research (Z.W.O.).

**Note added in proof.* Prof. Frey-Wyssling informs me that micro-analyses of Frey's fungi were made at Zurich after his paper had appeared. Barium could not be detected. This supports the above views concerning its origin in Frey's alkali extracted specimens, as does the fact that I obtained barium sulphate from alkali stored at 60° C. in certain types of Erlenmeyer vessels.

D. R. Kreger

Laboratory of General and Technical Biology,
Technical University,
Delft, Netherlands.
May 23.

[1] Frey, R., *Ber. Schweiz. Botan. Ges.*, **60**, 227 (1950).
[2] Houwink, A. L., and Kreger, D. R., "Antonie van Leeuwenhoek", 19 (1953).
[3] Kreger, D. R., *Biochim. Biophys. Acta*, **13**, 1 (1954).
[4] Robinson, W. O., Whetstone, R. R., and Edgington, G., U.S. Dept. Agric. Tech. Bull. 1013 (1950).

The Treatment of the Mentally Ill

The otherwise excellent article "The Treatment of the Mentally Ill" in *Nature* of August 10, p. 253, contains one surprising paragraph in which reference is made to "the excessive safeguards against wrong certification (which are now unnecessary)" and "In practice, the average psychiatrist rarely certifies anyone".

These remarks do not agree with the facts of the case, which are that, while the total number of admissions to mental hospitals has increased during recent years, the number of certified patients has not substantially decreased over the past twenty-five years, but remains static in the region of 20,000 annually, with only a slight decrease to 17,500 in 1956.

The writer of the article could not, I think, have read the several Parliamentary debates during the past year in which Mr. Norman Dodds, myself and others—including Dr. A. D. D. Broughton, the only practising psychiatrist in the House—have commented on the hasty and frequently unnecessary use of compulsory certification powers. It must be repeated that a single doctor, who need not be a psychiatrist, can under present law certify a patient after a minimum period of observation.

The Royal Commission only suggested the elimination of present 'safeguards' because they are obviously illusory and ineffective. Its proposals contain alternative safeguards which it is hoped will be more effective in preventing the unsatisfactory use of compulsory powers which are so prominent a feature of the mental illness picture to-day.

The statement that "the scarcity of beds leads to patients being discharged too early rather than to their being unduly detained", which this paragraph also contains, does not correspond with the facts in numerous cases that have come to my notice over the past twelve months.

Donald McI. Johnson

House of Commons,
London, S.W.1.

Excessive safeguards against wrong certification exist inasmuch as a magistrate, who is unlikely to be instructed in mental illness, is included in those signing the document. In any event, although some 20,000 people are certified annually, it is very rare for genuine complaints of wrong certification to come to light. Most cases claiming it are in patients suffering from paranoid delusions of persecution. The few cases supported in the courts have been those of border-line mental deficiency (usually after some delinquency).

The average psychiatrist rarely certifies patients. Many patients are certified on what is known as a 'three-day order', which confines them to an observation ward for psychiatric investigation by an experienced medical man. A large number of these are never sent to a mental hospital but discharged.

As regards the question of scarcity of beds, we are informed that it is a matter of daily clinical experience to find that patients are being discharged prematurely. Editors.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 28

FARADAY SOCIETY (in the Lecture Theatre of the Department of Physical Chemistry, University of Cambridge, Free School Lane, Cambridge), at 4.30 p.m.—Prof. W. Jost (University of Göttingen): "Reactions in Detonations and Shock Waves"* (Bourke Lecture).

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. A. J. Shorter: "Historical Geography of English Paper Mills, 1495–1800".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO AND TELECOMMUNICATION SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Informal evening on "Domestic High-Fidelity Reproduction". Talk by Mr. J. Moir.

UNIVERSITY OF LONDON (in the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Mr. R. A. R. Tricker: "Physical Science".* (Fourth of a series of lectures on "Contemporary Ideas on Teaching Method".)

Tuesday, October 29

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. S. W. Wooldridge: "The Heritage in Physiographic Insight".* (First of six lectures on "The Heritage of the English Countryside". Further lectures on November 5, 12, 19, 26 and December 3 and 5.)

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. J. P. Shillingford: "The Study of the Circulation by Dye Curves".* (Fourth of fifteen lectures on "The Scientific Basis of Medicine" organized by the British Postgraduate Medical Federation. Further lectures on October 31, November 5, 7, 12, 14, 19, 21, 26, 28, December 3 and 5.)

SOCIETY OF COSMETIC CHEMISTS OF GREAT BRITAIN (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 7.30 p.m.—Dr. A. J. P. Martin: "Gas-Liquid Chromatography".

Wednesday, October 30

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. Sutton and Dr. J. V. Watson: "The Structure of the Ground South of Loch Duich, Ross-shire"; Dr. H. I. Drever and Mr. R. Johnston: "The Lower Margin of the Shiant Isles Sill (Outer Hebrides)".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. M. Telford: "Tropospheric Scatter System Evaluation".

SOCIETY FOR ANALYTICAL CHEMISTRY, MICROCHEMISTRY GROUP (in the restaurant room of "The Feathers", Tudor Street, London, E.C.4), at 6.30 p.m.—Discussion on "British Standards in Microchemistry", opened by Mr. C. Meredith and Mr. G. Ingram.

INSTITUTION OF MECHANICAL ENGINEERS, EDUCATION GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "The Place of Kinematics of Mechanisms in Engineering Curricula".

Thursday, October 31

FARADAY SOCIETY (in the Lecture Theatre, Inorganic Chemistry Laboratory, South Parks Road, Oxford), at 5 p.m.—Prof. W. Jost (University of Göttingen): "Flame Reactions"* (Bourke Lecture).

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. Rosemary Biggs: "Hæmophilia and Christmas Disease".* (Fifth of fifteen lectures of "The Scientific Basis of Medicine" organized by the British Postgraduate Medical Federation. Further lectures on November 5, 7, 12, 14, 19, 21, 26, 28 and December 3 and 5.)

UNIVERSITY OF LONDON (in the Swanley Hall, Wye College, Wye, near Ashford, Kent), at 8.15 p.m.—Mr. N. Tinbergen: "Some Problems of Animal Behaviour".*

Friday, November 1

ASSOCIATION OF APPLIED BIOLOGISTS (in the Lecture Hall of the British Museum (Natural History), Cromwell Road, South Kensington, London, S.W.7), at 10.50 a.m.—Symposium on "Domestic Insects and Allied Pests".

NORTH EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. C. C. Pounder: "The Marine Diesel Engine" (Andrew Laing Lecture).

BRITISH GLACIOLOGICAL SOCIETY (in the Geography Department, The University, Downing Place, Cambridge), at 8.30 p.m.—Mr. J. F. Nye: "Glacier Waves—Observation and Theory (Cambridge Austerdalsbre Expedition)".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1)—at 9 p.m.—Sir Hugh Beaver, K.B.E.: "Clean Air—What We Know and What We Do Not Know".

Saturday, November 2

BRITISH INTERPLANETARY SOCIETY (in the Tudor Room, Caxton Hall, Caxton Street, London, S.W.1), at 6 p.m.—Dr. J. W. S. Pringle, F.R.S.: "Conditions for Life".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SCIENTIFIC OFFICER (British subject normally resident in the United Kingdom, with an honours degree in agriculture or agricultural botany (or equivalent qualification) and a sound knowledge of the principles of genetics and practical plant breeding, and preferably with previous experience in the design and analysis of field trials) IN THE PLANT BREEDING DIVISION, Ministry of Agriculture, Loughgall, Co. Armagh—The Secretary, Civil Service Commission, Stormont, Belfast (October 30).

RESEARCH ASSISTANT (with postgraduate research experience, preferably in solid state physics) IN THE DEPARTMENT OF PHYSICS, for investigations on the magnetic properties of some of the transition elements and their alloys at high temperatures—The Registrar, The University, Sheffield (October 31).

SANDOZ RESEARCH FELLOW (with a medical qualification), for work in the Medical Unit on the effects of vasoactive peptides on the human circulation—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (October 31).

ASSISTANT LECTURER (with a science qualification and preferably a medical qualification) IN PHYSIOLOGY—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (November 1).

LECTURER IN BIOCHEMISTRY—The Secretary, The Queen's University of Belfast, Belfast, Northern Ireland (November 1).

HEAD (highly qualified in physics, and with suitable industrial and/or research experience, and some full-time and/or part-time university or technical college lecturing experience) OF THE DEPARTMENT OF PHYSICS (Grade IV), Brunel College of Technology, Woodlands Avenue, Acton, London, W.3—The Clerk to the Governing Body, Middlesex County Council Education Department, 10 Great George Street, London, S.W.1 (November 2).

LECTURER (graduate, with research and/or industrial experience, and experience in an important branch of applied chemistry, preferably polymers, plastics or dyeing) IN CHEMISTRY—The Principal, Derby and District College of Technology, Normanton Road, Derby (November 2).

LECTURER IN MECHANICAL ENGINEERING—The Registrar, The Manchester College of Science and Technology, Manchester 1 (November 8).

DAIRY OFFICERS (with a university degree in an agricultural science, preferably in dairying, or with postgraduate qualifications in dairying) in the Ministry of Agriculture, Federation of Rhodesia and Nyasaland—The Secretary (R), Rhodesia House, 429 Strand, London, W.C.2 (November 9).

RESEARCH FELLOW (graduate of any British university) IN BIOCHEMISTRY or MICROBIOLOGY—The Registrar, The University, Sheffield (November 9).

EXPERIMENTAL OFFICER, Grade 3 (with a degree or diploma with chemistry as a major subject and several years relevant experience) IN THE DEFENCE STANDARDS LABORATORIES of the Department of Supply, Australian Defence Scientific Service, Maribyrnong, Victoria, Australia, to undertake investigational work on the field of protective clothing and respirators—The Senior Representative (AP 84), Department of Supply, Australia House, Strand, London, W.C.2 (November 14).

ASSISTANT LECTURER IN GEOGRAPHY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (Hong Kong, November 15).

LECTURERS (2) or ASSISTANT LECTURERS (2) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Leeds 2 (November 18).

LECTURER IN PHYSICS at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (November 28).

PLANT PATHOLOGIST (with a good honours degree in botany, including mycology, and postgraduate research experience), for research on fungal diseases of fruit—The Secretary, East Malling Research Station, near Maidstone, Kent (January 1).

TUCKER-PRICE RESEARCH FELLOW (woman graduate of any university), for research in mathematics, natural science, or an allied subject—The Secretary, Girton College, Cambridge (January 15).

AERODYNAMICIST (with a first- or second-class honours degree or equivalent in physics, mathematics or engineering) at the Ministry of Power Safety in Mines Research Establishment, Sheffield, for new research programmes involving aspects of fluid mechanics ranging from shock tube flows to mixing of different densities at low speeds, also to act as consultant to the Establishment on aerodynamic problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.309/7A.

BIOCHEMICAL TECHNICIAN IN THE METABOLIC UNIT—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2.

DEPUTY DIRECTOR (with a good honours degree in some branch of natural science and considerable research experience) OF AGRICULTURAL RESEARCH, Federation of Nigeria, to take charge of one division of the Federal Department of Agriculture (Botany, Entomology, Soil Chemistry, Agronomy, or Plant Pathology) and to assist in the administration of the Department—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD/63/14/042.

LECTURER or ASSISTANT LECTURER IN PHYSICAL or INORGANIC CHEMISTRY at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1.

LECTURERS (with a degree or equivalent, and preferably industrial and/or teaching experience) IN TELECOMMUNICATIONS; and an ASSISTANT LECTURER (Grade "B") IN TELECOMMUNICATIONS—The Clerk to the Governors, Northern Polytechnic, Holloway, London, N.7.

METALLURGIST (male, with an honours degree) IN THE PHYSICAL CHEMISTRY SECTION of the Chemistry Department in the Battersea

(London) Laboratories, for research work on the physical chemistry of ferrous metallurgical processes—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "C.P.8".

PHYSICIST (with a good honours degree), for experimental research on convection in fluids—Prof. P. A. Sheppard, Meteorology Department, Imperial College, London, S.W.7.

PHYSICISTS (with a degree or equivalent, and preferably experience in X-ray crystallography or, alternatively, an interest in this field with some research experience) at the Research Laboratories, Leatherhead, Surrey, for work on X-ray diffraction analysis—The Director of Establishments, Central Electricity Authority, Winsley Street, London, W.1, quoting Ref. N/436.

PHYSIOLOGICAL LABORATORY SUPERINTENDENT (with experience in laboratories of a teaching institute, a specialized knowledge of physiology and biology, and able to maintain physiological apparatus) in the Nigeria Northern Region Medical Department, for duties which include assistance in laboratory work to trainee pharmacists—The Crown Agents, 4 Millbank, London, S.W.1, quoting M.3/44413/NF.

RESEARCH ASSISTANT (with a degree in zoology and interested in the development of cytological and/or physiological techniques) IN THE DEPARTMENT OF ZOOLOGY—The Registrar, The University, Nottingham.

RESEARCH ASSISTANTS (2) (preferably with a degree in electrical engineering or physics) IN THE DEPARTMENT OF ELECTRICAL ENGINEERING (one to work on the development of a new solid-state device; and one on the development of a new beam-scanning principle in echo-ranging)—The Professor of Electrical Engineering, The University, Birmingham 15.

SCIENTIFIC OFFICERS (with a first- or second-class honours degree, preferably in physics or mathematics) IN THE METEOROLOGICAL OFFICE, for duties which include research in atmospheric physics, covering the study of cloud structure, synoptic and dynamical meteorology, large- and small-scale diffusion and turbulence, climatology and the development of instruments—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting No. S.52/57 (Met.).

SENIOR LECTURER IN PHYSICS; and a LECTURER IN PHYSICS—The Clerk to the Governors, Northern Polytechnic, Holloway, London, N.7.

SENIOR LECTURER (preferably with an active interest in research in some branch of applied mathematics) IN MATHEMATICS, to teach up to degree standard; a LECTURER IN MATHEMATICS, to teach pure and applied mathematics to degree standard; a LECTURER (preferably with industrial experience, and research interests in physical or inorganic chemistry) IN CHEMISTRY, to teach up to degree standard; and an ASSISTANT LECTURER (with teaching experience) IN CHEMISTRY (Grade B)—The Clerk to the Governors, Northern Polytechnic, Holloway, London, N.7.

TECHNICIAN (with university or I.M.L.T. qualifications), for biochemical research—The Secretary, Institute of Psychiatry, The Maudsley Hospital, Denmark Hill, London, S.E.5, quoting Ref. M.R.C. B.10.

X-RAY CRYSTALLOGRAPHER (at least Ph.D. standard, and preferably with several years experience), for work on fibrous proteins—The Director, Medical Research Council, Biophysics Research Unit, King's College, Strand, London, W.C.2.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 973, Vol. 250 (8 August, 1957): The Caesium Resonator as a Standard of Frequency and Time. By L. Essen and J. V. L. Parry. Pp. 45–69. (London: Royal Society of London, 1957.) 8s. [78

Bulletin of the British Museum (Natural History). Entomology. Vol. 5, No. 3: A Revision of the Arhopala Group of Oriental Lycaenidae (Lepidoptera: Rhopalocera). By W. H. Evans. Pp. 85–141. 15s. Vol. 5, No. 4: A Revision of the *Bruchus* (Malliophaga) Species Infesting the Corvidae, Part 2. By M. Atiqur Rahman Ansari. Pp. 143–182. 12s. Index to Vol. 4 (1955–1957). Pp. 12. Zoology. Vol. 5, No. 3: The Pelecaniform Characters of the Skeleton of the Shoe-Bill Stork, *Balaeniceps rex*. By Patricia A. Cottam. Pp. 49–72+plate 3. 8s. Index to Vol. 4 (1956–1957). Pp. 8. (London: British Museum (Natural History), 1957.) [78

British Museum (Natural History). Economic Leaflet No. 3: The Silver Fish and Firebrat. Pp. 3. (London: British Museum (Natural History), 1957.) 1d. [78

British Broadcasting Corporation. Engineering Monograph No. 13: The B.B.C. Riverside Television Studios: The Architectural Aspects. By E. A. Fowler. Pp. 25. (London: British Broadcasting Corporation, 1957.) 5s. [148

An Appeal to Scientists to Consider their Personal Responsibility for the Development of Nuclear Weapons and for other Applications of Science to Warfare. Pp. 6. (Leigh-on-Sea: Clerk to the Quaker Scientists' Fellowship, 106 Olive Avenue, 1957.) [148

Department of Scientific and Industrial Research. Food Investigation 1956: The Report of the Food Investigation Board with the Report of the Director of the Food Investigation Organization. Pp. vi+68. (London: H.M. Stationery Office, 1957.) 3s. 6d. net. [148

National Institute for Research in Dairying: University of Reading. Report, 1956. Pp. 158. (Shinfield, Reading: National Institute for Research in Dairying (University of Reading), 1957.) [148

Building Research Station Digest. No. 100 (July, 1957): Taking Stock (with Index to Digests Nos. 1 to 100). Pp. 10. (London: H.M. Stationery Office, 1957.) 3d. [148

Ovaltine Research Laboratories. Sixteenth Annual Report (1956). Pp. 10. (London: A. Wander, Ltd., 1957.) [158

Other Countries

A Bibliography of Syntheses with Carbon Isotopes, 1953–54. Compiled by Judd C. Nevenzel, David R. Howton, Richard F. Riley and Gunther Steinberg. (University of California, Los Angeles Campus, School of Medicine. UCLA Report 395.) Pp. 172. (Washington, D.C.: Office of Technical Services, Department of Commerce, 1957.) 1 dollar. [78

Southern Rhodesia. Report of the Trustees and Director of the National Museums of Southern Rhodesia for the year ended 31st December, 1956. Pp. 21. (Bulawayo: National Museums of Southern Rhodesia, 1957.) [148

Union of South Africa: Department of Commerce and Industries. Investigational Report No. 26: The South African Pilchard (*Sardinops ocellata*). Size Composition of the Commercial Catches, 1950–55. By Dr. D. H. Davies. Pp. 60. (Reprint from *Commerce and Industry*.) (Sea Point, Cape Town: Division of Fisheries, 1957.) [148

A World Periodicals List for Fisheries Science. Prepared by the Biology Branch, Fisheries Division, F.A.O., Rome. 1st Draft—May 10, 1957. Pp. 87. (Rome: Food and Agriculture Organization of the United Nations, 1957.) [148

Commonwealth of Australia: Department of Supply—Research and Development Branch. Annual Report of the Defence Standards Laboratories for the year ended 30th June, 1956. Pp. iv+44. (Maribyrnong, Victoria: Defence Standards Laboratories, 1947.) [148

International Nickel Company of Canada, Ltd. Interim Report to Shareholders for the six months ended June 30, 1957. Pp. 4. (Copper Cliff, Ontario: International Nickel Company of Canada, Ltd., 1957.) [148

Geological Survey of Nigeria. Bulletin No. 26: Lower Turonian Ammonites from North-Eastern Nigeria. By W. Barber. Pp. 68+3 maps+34 plates. (Kaduna Junction, Nigeria: Geological Survey of Nigeria, 1957.) 20s. [158

National Academy of Sciences—National Research Council, Washington. Digest of Literature on Dielectrics, Vol. 19, 1955. Prepared by the Committee on Digest of Literature of the Conference on Electrical Insulation. Edited by R. W. Crowe and J. D. Hoffman. Pp. x+238. (Publication 503.) (Washington, D.C.: National Academy of Sciences—National Research Council, 1957.) 5 dollars. [158

United States Department of the Interior: Geological Survey. Bulletin 1021-M: Ordovician Fossils from Wells in the Williston Basin, Eastern Montana. By Reuben James Ross, Jr. Pp. iv+439–510+plates 37+44. 1 dollar. Bulletin 1024-G: Some Pegmatite Deposits of Southeastern Alaska. By C. L. Sainsbury. Pp. iv+141–162+plate 19. 25 cents. Bulletin 1024-H: A Geochemical Exploration for Antimony in Southeastern Alaska. By C. L. Sainsbury. Pp. iv+163–178+plates 20–22. 70 cents. Bulletin 1041-C, D, E: Coalfields of the Republic of Korea, Part 2. Geology of Macha-ri Coalfield. By John A. Reinemund. Geology of Hambaek Coalfield. By Ewart M. Baldwin. Geology of Tangyang Coalfield. By Kenneth G. Brill, Jr. Pp. viii+11–100+8 plates. n.p. Bulletin 1042-E: Physical Stratigraphy of the Phosphoria Formation on Northwestern Wyoming. By Richard P. Sheldon. Pp. v+185+plates 9–13. n.p. Bulletin 1042-G: Gem Stones of the United States. By Dorothy M. Schlegel. Pp. iii+203–254. 25 cents. Bulletin 1045-A: Core Logs from Owens, China, Searles, and Panamint Basins, California. By George I. Smith and Walden P. Pratt. Pp. iii+61. 55 cents. Bulletin 1048-D: Geophysical Abstracts 167, October–December 1956. By Mary C. Rabbitt, Dorothy B. Vitaliano, S. T. Vesselowsky and others. Pp. iii+293–450. 25 cents. Washington, D.C.: Government Printing Office, 1957.) [168

United States Department of the Interior: Geological Survey. Water-Supply Paper 1289: Surface Water Supply of Hawaii, 1952–53. Prepared under the direction of J. V. B. Wells. Pp. vi+136. 45 cents. Water-Supply Paper 1326: Water Levels and Artesian Pressures in Observation Wells in the United States, 1954. Part 6: Southwestern States and Territory of Hawaii. Prepared under the direction of A. N. Sayre. Pp. vii+262. 1 dollar. Water-Supply Paper 1337: Surface Water Supply of the United States, 1954. Part 4: St. Lawrence River Basin. Prepared under the direction of J. V. B. Wells. Pp. ix+422. 1.50 dollars. Water-Supply Paper 1338: Surface Water Supply of the United States, 1954. Part 5: Hudson Bay and Upper Mississippi River Basins. Prepared under the direction of J. V. B. Wells. Pp. xii+555. 1.75 dollars. Water-Supply Paper 1340: Surface Water Supply of the United States, 1954. Part 6-B: Missouri River Basin below Sioux City, Iowa. Prepared under the direction of J. V. B. Wells. Pp. x+443. 1.50 dollars. Water-Supply Paper 1360-F: Salt Water and Its Relation to Fresh Ground Water in Harris County, Texas. By Allen G. Winslow, William W. Doyel, and Leonard A. Wood. Pp. iii+375–408+plates 24–27. n.p. Water-Supply Paper 1360-G: Ground-Water Conditions in the Mendota-Huron Area, Fresno and Kings Counties, California. By G. H. Davis and J. F. Poland. Pp. iv+409–588+plates 28–36. n.p. Water-Supply Paper 1361: Geology and Ground Water Resources of the York-James Peninsula, Virginia. By D. J. Cederstrom. Pp. vii+237+9 plates. 1.75 dollars. (Washington, D.C.: Government Printing Office, 1957.) [168

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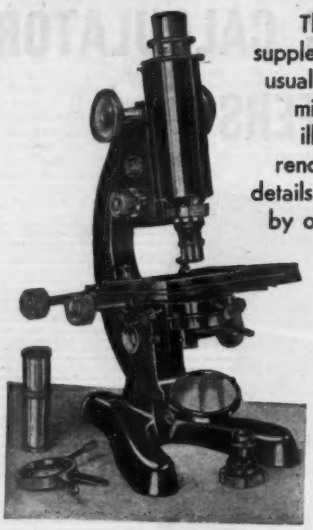

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